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Field Studies on USBM and TOSCO II Retorted Oil Shales: Vegetation, Moisture Salinity, and Runoff, 1977-1980

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FIELD STUDIES ON USBM AND TOSCO II RETORTED OIL SHALES:
Vegetation, Moisture, Salinity, and Runoff, 1977-1980

by

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Field studies were initiated in 1973 to investigate the vegetative stabilization of processed oil shales and to follow moisture and soluble salt movement within the soil/shale profile. Research plots with two types of retorted shales (TOSCO II and USBM) with leaching and soil cover treatments were established at two locations: low-elevation (Anvil Points) and high-elevation (Piceance Basin) in western Colorado. Vegetation was established by intensive management including leaching, N and P fertilization, seeding, mulching, and irrigation.

After seven growing seasons, a good vegetative cover remained with few differences between treatments, with the exception of the TOSCO retorted shale, south-aspect, which consistently supported less perennial vegetative cover than other treatments. With time, a shift from perennial grasses to dominance by shrubs was observed. Rodent activity on some treatments had a significantly negative effect on vegetative cover.

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FOREWORD

When energy and material resources are extracted, processed, converted, and used, the related pollutional impacts on our environment and even on our health often require that new and increasingly more efficient pollution control methods be used. The Industrial Environmental Research Laboratory - Cincinnati (IERL-Ci) assists in developing and demonstrating new and improved methodologies that will meet these needs both efficiently and economically.

This study investigated the vegetative stabilization of TOSCO II and USBM processed shales with and without soil covers at a low-elevation (Anvil Points) and a high-elevation (Piceance Basin) in western Colorado. Parameters such as moisture and soluble salts in the treatment profiles were also monitored. Results should be useful to government agencies and private industries involved with developing control technology methods for retorted oil shale disposal. For more information, contact the Oil Shale and Energy Mining Branch of the Energy Pollution Control Division.

David G. Stephan
Director
Industrial Environmental Research Laboratory
Cincinnati

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ABSTRACT

Field studies were initiated in 1973 to investigate the vegetative stabilization of processed oil shales and to follow moisture and soluble salt movement within the soil/shale profile. Research plots with two types of retorted shales (TOSCO II and USBM) with leaching and soil cover treatments were established at two locations: low-elevation (Anvil Points) and high-elevation (Piceance Basin) in western Colorado. Vegetation was established by intensive management including leaching, N and P fertilization, seeding, mulching, and irrigation.

After seven growing seasons, a good vegetative cover remained with few differences between treatments, with the exception of the TOSCO retorted shale, south-aspect, which consistently supported less perennial vegetative cover than other treatments. With time, a shift from perennial grasses to dominance by shrubs was observed. Rodent activity on some treatments had a significantly negative effect on vegetative cover.

After initial irrigation for establishment, the vegetation was dependent on seasonal precipitation. Spring snowmelt resulted in recharge of profiles to depths of 60 to 120 cm. By fall, plant-available moisture was depleted by evapotranspiration. Although the fine-textured TOSCO retorted shale usually produced the greatest runoff of all treatments, the surface runoff and sediment yields were generally low due to the adequate vegetative cover. Initially, some accumulation of soluble salts occurred at the surface because of ineffective leaching. With subsequent weathering, salinity decreases throughout the entire profile of most treatments were observed. Recorded surface temperatures of the black TOSCO retorted shale were sufficiently high to limit seedling establishment and increase surface evaporation.

This report follows an initial report by Harbert and Berg (1978) which detailed the construction, establishment techniques, and interpretation of measurements from 1973 to 1976.

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ABBREVIATIONS AND SYMBOLS

cm	centimeter
CSU	Colorado State University
DTPA	diethylenetriamine pentaacetic acid
EC	electrical conductivity
mmhos/cm	millimhos per centimeter
μmhos/cm	micromhos per centimeter
ha-m	hectare-meter
kg/ha	kilogram per hectare
km	kilometer
ℓ	liter
meq/ℓ	milliequivalent per liter
pH	a numerical designation of acidity and alkalinity
ppm	parts per million
SAR	sodium adsorption ratio
SD	standard deviation
TDS	total dissolved solids
TOSCO	Tosco Corporation
USBM	United States Bureau of Mines
$\bar{X}$	mean

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The U.S. Bureau of Mines for providing the Anvil Points study site and irrigation water in addition to the USBM retorted shale.

The Colony Development Operation for providing and loading the TOSCO retorted shale.

The Bureau of Land Management for the Piceance Basin study site and use of a water storage tank.

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Russell Scott
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SECTION I

INTRODUCTION

In recent years the need to develop new energy resources within the United States has become increasingly important. In 1973 the U.S. Department of Interior estimated that the western oil shale reserves, consisting of over 64,750 square kilometers in Colorado, Wyoming, and Utah, contained over 9.5×10^{13} ℓ (600 billion barrels) of recoverable crude oil. These previously undeveloped areas, used largely as range and wildlife habitats, will be subject to vast land disturbances with the development of an oil shale industry.

Various waste products will be generated by shale processing methods making it necessary to develop control technology in order to limit the environmental impact. One of the major environmental problems associated with oil shale development is the disposal of the massive amounts of waste material produced. The U.S. Department of Interior (1973) estimated that a mature oil shale industry of 1.6×10^{8} ℓ of oil/day (one million barrels of oil/day) would generate approximately 20,000 ha-m per year of waste material with surface retorting methods. Part of this waste might be returned to mined areas, but a large proportion would require surface disposal. Not only the large volume, but also the chemical and physical characteristics of the waste will create challenges for the development of control technology.

A part of the solution to the management of processed shales would be the rapid establishment of a satisfactory vegetative cover on disposal piles. Vegetation would stabilize the processed shale by decreasing water and wind erosion. Transpiration by vegetation would also result in less moisture available for deep percolation. Establishment of vegetation would also aid in returning the area to a range and wildlife habitat, and provide a more aesthetic landscape.

To make reasonable predictions about the environmental impact of an oil shale industry it is necessary to investigate both the chemical and physical properties of the waste material. Factors affecting the characteristics of the retorted shale include the natural variation in the raw shale, the degree to which the raw shale was crushed prior to retorting and the retorting process itself.

In addition to physical and chemical characteristics of the retorted shale, the location of the disposal sites in a region of complex geomorphology and varied climatic regimes will influence the success of disposal management efforts.

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Thus, the following studies were initiated to evaluate intensive management techniques for the vegetative stabilization of processed oil shales: two locations were chosen to simulate disposal sites (a low-elevation and a high-elevation). Various leaching and soil cover treatments were applied to two types of processed shales (TOSCO II and USBM). The objectives of this study were to investigate surface stability and to monitor moisture and soluble salts in the treatment profiles.

This report deals most specifically with the collection and interpretation of data from 1977 through 1980, although references and comparisons are made to the 1976 growing season. A more detailed description of results from 1973 to 1976 is reported in Harbert and Berg (1978).

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SECTION II

CONCLUSIONS

LOW-ELEVATION STUDY SITE

Vegetation

1. After seven growing seasons, a good vegetative cover (52% to 68%) existed on all treatments.

2. The TOSCO retorted shale, with no soil cover, generally supported less perennial vegetation throughout the years, than other treatments.

3. A shift in vegetative composition from perennial grasses to predominance by xeric shrubs occurred on all treatments.

Moisture

1. With average seasonal precipitation most treatment profiles were recharged to levels of 20% to 25% moisture by volume in the spring to depths of 60-120 cm.

2. Good vegetative cover, especially deeper-rooted shrubs, extracted substantial moisture from all treatment profiles to approximately 10% moisture by volume by fall.

3. South-facing slopes reflected a drier soil moisture regime than north-facing slopes by a more rapid shift from grasses to xeric shrubs.

Salinity

1. Leached treatments of the fine-textured TOSCO shale initially experienced some accumulation of surface salts, and salinization of soil covers over retorted shale.

2. Seasonal precipitation in later years reduced salinity levels to 5 mmhos/cm or less throughout the entire profile of leached treatments with no indication of upward salt migration.

Runoff and Water Quality

1. The quantity and quality of spring snowmelt runoff depended on whether the ground surface was frozen or thawed.

2. A greater runoff volume resulted when the ground surface was frozen, and was of high water quality.

3. Small amounts of runoff in 1978 were rated medium to very high salinity hazard (1210 - 3200 µmhos/cm).

4. The use of a mulch during vegetative establishment and the present vegetative cover contributed to low sediment yields for all treatments.

Surface Temperatures

1. Maximum temperatures of 60-65°C at a 1 cm depth were recorded in mid-summer on TOSCO south-facing plots. Temperatures from south-facing soil plots were about 5°C lower.

2. On north-facing TOSCO shale plots temperatures at 1 cm depth were approximately 50°C, compared to 30°C for north-facing soil plots.

HIGH-ELEVATION STUDY SITE

Vegetation

1. The initial vegetation established in 1974 was unsatisfactory because: perennial grasses were seeded at a low rate, a too dense stand of big sagebrush resulted, and the inadequately leached retorted shales were resalinized.

2. After releaching, rototilling, and reseeding a good stand resulted.

3. Rodent activity, particularly pocket gophers, caused considerable surface disturbance resulting in a loss of vegetative cover.

4. A shift from perennial grasses to predominance by xeric shrubs was observed.

Moisture

1. Spring snowmelt resulted in recharge of profiles to depths of 60-120 cm.

2. Evapotranspiration resulted in depletion of plant-available moisture in the profiles by fall.

Salinity

1. Due to high evaporative demand and low irrigation rates, resalinization of the leached layer over the retorted shales resulted in 1974.

2. Resalinization did not occur after the 1975 releaching.

3. Seasonal precipitation and continued weathering reduced soluble salts to 5 mmhos/cm or less throughout the entire profile of leached treatments by 1980, with no indication of upward salt movement.

Runoff and Water Quality

1. Spring snowmelt was responsible for the majority of surface runoff on all treatments.

2. When small amounts of runoff resulted, from either limited snowmelt or summer thunderstorms, the salinity hazard was rated high to very high from the retorted shales (1120 - 7200 μmhos/cm).

3. The sodium hazard and sediment yields were rated low for runoff from all treatments.

SECTION III

RECOMMENDATIONS

1. Intensive management will be required to establish a satisfactory vegetative cover within a reasonable amount of time.

2. As a specific retorting method develops, investigation of the waste as a plant growth media requires a thorough examination of the physical and and chemical characteristics of the retorted shale.

3. The eventual erosion of soil cover or modified retorted shale, particularly from steep south-facing slopes, could result in continued exposure of less weathered retorted shale. This should be considered in future waste stabilization research and planning.

4. The ultimate fate of applied leach water, along with a comprehensive water balance (especially for high-elevation disposal sites) should be addressed.

5. Large herbivores were restricted from the small plots in this study by fencing, future research should evaluate both wildlife and domestic livestock use on the retorted shale disposal site.

6. The retorted shale disposal site stabilization plan must allow for localized severe rodent disturbances as observed in this study.

SECTION IV

MATERIALS AND METHODS

Field studies were initiated in 1973 to investigate the vegetative stabilization potential of retorted oil shales. The objectives were to examine surface stability and soluble salt movement in retorted oil shales. Two types of processed shale, USBM and TOSCO II, with various leaching and soil cover treatments were used. Study plots were established at two sites to simulate conditions existing at proposed shale waste disposal sites (Figure 1). The low-elevation site at Anvil Points (1,700 m) has a semi-arid climate and sparse natural vegetation of low-elevation pinyon-juniper woodlands. This site receives approximately 30 cm of annual precipitation. The vegetation types at the high-elevation Piceance Basin site (2,200 m) were high-elevation big sagebrush shrubland and low-elevation pinyon-juniper woodland. With an

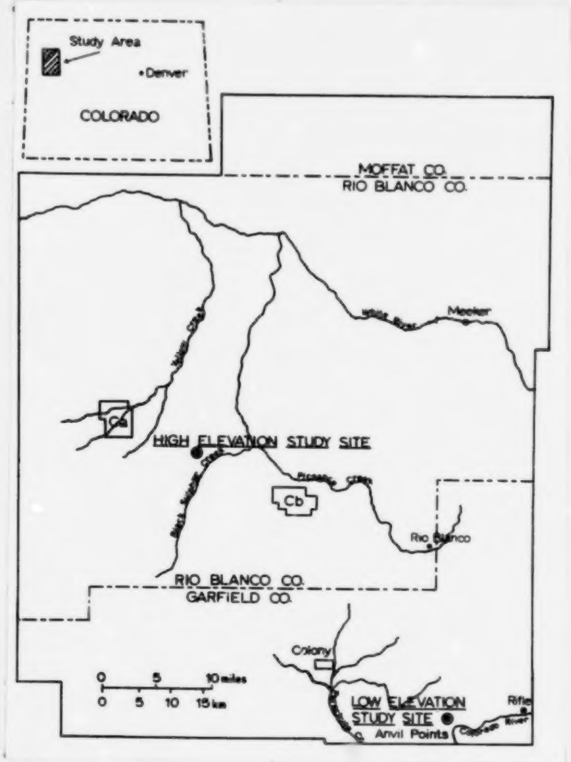
Study Area
Denver
COLORADO
MOFFAT CO.
RIO BLANCO CO.
White River
Meeker
Ca
HIGH ELEVATION STUDY SITE
Piceance Creek
Cb
Rio Blanco
RIO BLANCO CO.
GARFIELD CO.
Colony
0 5 10 miles
0 5 10 15 km
LOW ELEVATION STUDY SITE
Anvil Points
Rifle
Colorado River

Figure 1. Location of the low- and high-elevation study sites.

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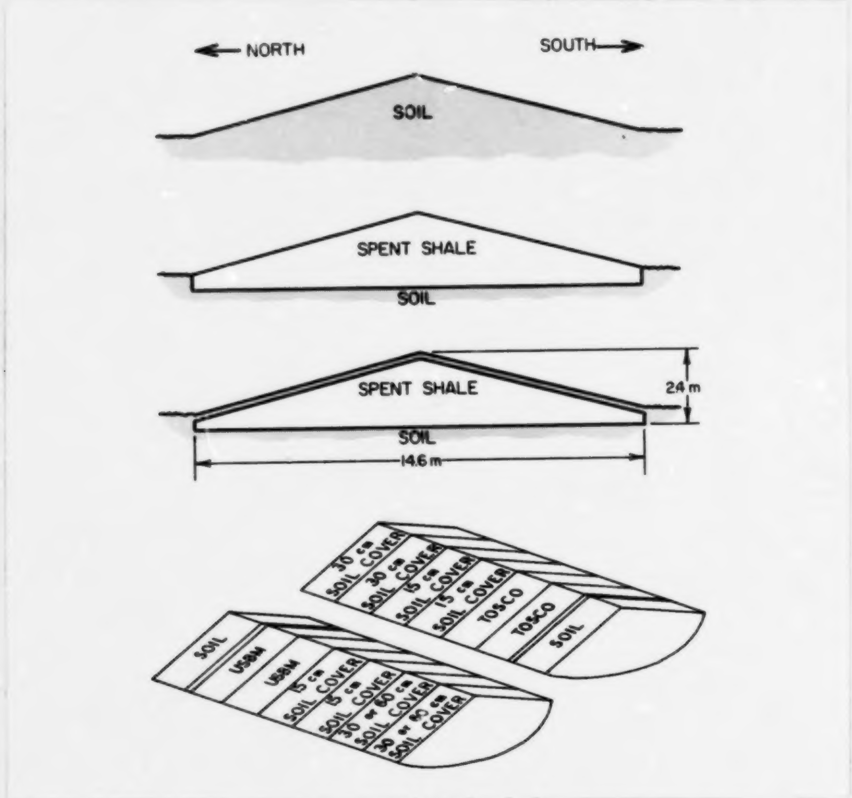
estimated average precipitation annually of 40 cm, this site was very similar in climate, elevation, and vegetation to the Colorado Federal Oil Shale lease sites in the Piceance Creek Basin.

Each research site contains a set of 3.3 m x 6.6 m plots with the following treatments:

1. Leached TOSCO retorted shale
2. Leached TOSCO retorted shale with 15-cm soil cover
3. Unleached TOSCO retorted shale with 30-cm soil cover
4. Leached USBM retorted shale
5. Leached USBM retorted shale with 15-cm soil cover
6. Unleached USBM retorted shale with 30-cm soil cover at the high-elevation site or 60-cm soil cover at the low-elevation site
7. Soil control

Each of the seven replicated treatments had a north and a south exposure on a 4:1 (25%) slope. A diagram of the treatment arrangement at each site is shown in Figure 2.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USBM
15 cm SOIL COVER
15 cm SOIL COVER
30 or 60 cm SOIL COVER
30 or 60 cm SOIL COVER

Figure 2. Diagram of the low- and high-elevation study treatments.

The two retorted shales used in this study were products of retorting processes developed by Tosco Corporation (TOSCO II) and the U.S. Bureau of Mines (USBM). Some chemical and physical characteristics of these retorted shales have been determined by Schmehl and McCaslin (1973) (Table 1) and Ward et al. (1971).

TABLE 1. PHYSICAL AND CHEMICAL CHARACTERISTICS OF TOSCO II AND USBM RETORTED SHALES (SCHMEHL AND McCASLIN, 1973).

	TOSCO	USBM
pH	9.2	8.6
EC (mmhos/cm)	17.7	16.6
SAR	29.0	14.1
Texture	silt loam	gravelly silt loam
>2 mm	14%	62%
<2 mm	86%	38%
Field Moisture Capacity % H_2O (<2 mm material)	20.9%	19.8%

The TOSCO retorted shale was black, silt loam material retorted at the Colony Development Operation near Parachute, Colorado. The TOSCO retorting process was described by Lenhart (1969). The USBM retorted shale was black-gray and contained approximately 60% coarse particles (>2 mm) and 40% soil-sized particles (<2 mm). The USBM retorted shale was retorted by a gas-combustion method described by Matzick et al. (1966).

Because these shales were retorted under experimental conditions, they may not be representative of later commercially produced material. Several years between retorting and initiation of these field studies allowed some physical and chemical changes to occur due to weathering. The USBM shale was retorted earlier and may have initially had a higher pH than when used for these studies.

The soils for the experimental control were classified as a calcareous silty clay loam at the low-elevation site, and a non-calcareous silt loam at the high-elevation site.

Construction was completed at both the high-elevation and low-elevation site in 1973. After filling operations, the plots were outfitted with salinity sensors buried at 20 and 50 cm depths. Because of erratic readings, their use was discontinued in 1978. Neutron probe access tubes were also installed

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to monitor moisture patterns to a depth of 150 cm throughout the growing season by neutron probe. A surface runoff collection system provided information on the quality and quantity of runoff from spring snowmelt or summer thunderstorms. A tipping-bucket rain gauge and recorder at each study site, as well as a hygrothermograph (during the growing season) supplied climatological data.

Those treatments requiring leaching were sprinkler irrigated after construction. The low-elevation site, leached treatments, received a total of 100 cm of water. The high-elevation site, leached treatments, were irrigated by hauling water, on an intermittant basis. Because of the high evaporation rate, and low application rate, leaching was generally ineffective, and salinization of the surface occurred at the high-elevation site. Additional irrigation of 100 cm in 1975 applied continuously by sprinkler succeeded in leaching the soluble salts from the surface at this site.

After leaching, nitrogen and phosphorus fertilizers were applied to all treatments at both study sites. Phosphorus was incorporated to a depth of 10 cm at the rate of 400 kg P/ha in the form of triple superphosphate. Nitrogen was applied following germination at the rate of 66 kg N/ha as ammonium nitrate. Supplemental maintenance nitrogen was applied in following years by broadcasting 66 kg N/ha when spring regrowth began. Fertilization with nitrogen was discontinued in 1979.

The low-elevation study site was seeded in June 1973 with a mixture of native grasses and shrubs (Table 2). After lightly raking, a mulch of grass hay was applied and held with cotton netting. Although the high-elevation site was initially seeded in 1974, because of the salinity problems mentioned, this site was rototilled and reseeded in June 1975 with the native mix shown in Table 3. Irrigation aided the establishment of vegetation at both study sites, the first growing season. The low-elevation site received a total of 46 cm of water, while the high-elevation site received approximately 20 cm of water for stand establishment. Neither study site received any additional irrigation in following seasons, but was dependent upon naturally occurring precipitation.

Core samples were taken 1973 through 1975. In later years the plots were core sampled on an intermittant basis to minimize disturbance. Salinity measurements on a 1:1 by weight, soil to water ratio, were performed on 15 cm increments of the core samples. A saturated paste extract was not used because of the large sized sample required, as well as the physical characteristics of the retorted shales.

Two methods of vegetative measurements were used. The quadrat method was used to provide an estimate of germination and establishment the first two years after seeding. The line-intercept method was used in later years to provide a more quantitative measurement. In 1976, the low-elevation study site was analyzed for total aboveground standing biomass.

A more detailed account and description of the construction and measurements for 1973 through 1976 was presented in an earlier report (Harbert and Berg, 1978).

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TABLE 2. SEED MIXTURES AND RATES FOR THE LOW-ELEVATION STUDY, JUNE 11, 1973.

Species	Rate (kg/ha)
GRASSES	
Bluebunch wheatgrass (*Agropyron spicatum*)	2.2
Indian ricegrass (*Oryzopsis hymenoides*)	2.2
Western wheatgrass (*Agropyron smithii*)	1.1
SHRUBS	
Big sagebrush (*Artemisia tridentata*)	0.5
Fourwing saltbush (*Atriplex canescens*)	1.1
Rabbitbrush (*Chyrsothamnus* spp.)	0.5
Winterfat (*Ceratoides lanata*)	1.1

TABLE 3. SEED MIXTURES AND RATES FOR THE HIGH-ELEVATION STUDY, JUNE 10, 1975.

Species	Rate (kg/ha)
GRASSES	
Bluebunch wheatgrass (*Agropyron spicatum*)	0.5
Western wheatgrass (*Agropyron smithii*)	1.1[†]
Galleta (*Hilaria jamesii*)	0.5
Basin wildrye (*Elymus cinereus*)	0.5
Indian ricegrass (*Oryzopsis hymenoides*)	2.2
FORBS	
Lupine spp. (*Lupine* spp.)	0.5
Utah sweetvetch (*Hedysarum boreale utahensis*)	1.7
Arrowleaf balsamroot (*Balsamorhiza sagittata*)	0.5
James penstemon (*Penstemon jamesii*)	1.1
Penstemon spp. "Bandera" (*Penstemon* spp.)	0.2
SHRUBS	
Antelope bitterbrush (*Purshia tridentata*)	2.2
Fourwing saltbush (*Atriplex canescens*)	2.2
Rabbitbrush (*Chrysothamnus* spp.)	2.2
Winterfat (*Ceratoides lanata*)	2.2

[†] This rate was doubled on both the TOSCO and USBM spent shale plots.

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SECTION V

RESULTS AND DISCUSSION

PRECIPITATION

A tipping bucket rain gauge with a continuous chart recorder was installed at both high- and low-elevation study sites. These gauges were not wind shielded, therefore, loss of precipitation in the form of snow during winter months was expected. Precipitation data for 1976-1980 are reported for both study sites in Table 4. The average annual precipitation for the low-elevation study site was estimated to be 30 cm, while that for the high-elevation was estimated to be 40 cm. Evidently the tipping bucket gauge even though correctly calibrated, did not adequately register annual precipitation in the form of snow.

TABLE 4. MONTHLY PRECIPITATION FOR THE LOW- AND HIGH-ELEVATION STUDY SITES, 1976-1980.

Month	Low-Elevation Site					High-Elevation Site				
	1976	1977	1978	1979	1980	1976	1977	1978	1979	1980
					cm					
January	0.4	1.5	4.8	0.7	5.5	5.1	1.0	1.3	0.5	1.2
February	5.9	0.6	3.5	4.5	9.2	7.1	1.3	1.0	0.4	1.7
March	3.7	2.2	9.2	3.3	5.9	0.6	2.0	2.8	1.3	3.5
April	3.4	0.9	3.4	0.6	2.1	3.4	3.5	2.7	0.6	1.4
May	4.0	1.5	2.6	4.1	6.4	5.2	1.4	3.7	6.0	2.8
June	1.8	0.5	0.6	1.2	0.0	2.5	0.5	0.6	0.7	0.0
July	1.2	-	0.2	1.7	3.0	1.2	3.4	0.5	0.9	2.9
August	2.5	4.8	1.1	3.3	2.2	3.4	3.9	0.6	2.9	2.6
September	3.8	3.7	2.0	0.4	0.6	2.2	3.5	0.2	0.4	1.2
October	1.4	2.2	0.1	2.0	4.8	0.7	2.3	0.3	3.3	2.9
November	0.1	-	5.1	3.0	1.5	0.1	1.9	1.4	1.4	0.3
December	0.1	2.5	2.9	0.6	1.6	0.1	0.7	0.3	0.6	0.9
TOTAL	28.3	20.4	35.5	25.4	42.8	31.6	25.4	15.4	19.0	21.4

- Incomplete data.

Almost all of Colorado was subjected to a drought during the 1976-1977 winter season. Lack of snowfall, combined with low spring precipitation, resulted in considerable moisture stress to vegetation at both study sites. Precipitation for the summer months was also unusually low at the high-elevation site for 1978. A cylinder type precipitation gauge at this site measured approximately double the precipitation recorded by the tipping bucket gauge January through April 1978, when snow was a major form of precipitation.

LOW-ELEVATION STUDY SITE

Vegetation

Over the 1973-1976 growing period an adequate stand of native perennial grasses and shrubs was established (Harbert and Berg, 1978). The application of water for leaching and establishment in 1973 provided a reservoir of moisture in the soil or retorted shale profiles for plant use. Only after the 1975 growing season were the moisture recharge and extraction patterns dependent upon the natural precipitation. Because of this, 1976 vegetation data has been used in this report as a comparison for vegetation changes in later growing seasons.

In 1976 there was an adequate stand of native perennial species on all treatments except for the TOSCO retorted shale which was dominated by annuals (Tables 5 and 6). Overall, north slopes supported more vegetation than drier south slopes. Below average precipitation over the 1976-1977 winter combined with a drought during the 1977 growing season resulted in significantly less vegetative cover on all treatments in 1977. With a return to nearly average precipitation in 1978 and 1979 the vegetation recovered and reached levels comparable to that before the drought (Table 5).

TABLE 5. VEGETATIVE COVER FOR THE LOW-ELEVATION STUDY TREATMENTS, 1976-1980.

Treatment	1976	1977	1978	1979	1980
	- - - - - - - -	- - - - - - - -	- - - - - - % - - - - - -	- - - - - - - -	- - - - - - - -
TOSCO Spent Shale	73	29	66	59	60
15 cm Soil Cover/TOSCO	80	32	76	78	53
30 cm Soil Cover/TOSCO	75	46	70	78	68
USBM Spent Shale	79	53	66	79	55
15 cm Soil Cover/USBM	87	38	73	81	55
60 cm Soil Cover/USBM	84	43	78	82	60
Soil Control	84	36	76	81	52

The most noticeable change over the 1976-1980 growing period was the change in species composition from a population dominated by perennial grasses to one dominated by shrubs (Table 6). The south slopes showed a greater decrease in perennial grasses and a greater increase in shrubs than did the north slopes. Most of the shrub cover increase was due to the large spreading canopy of fourwing saltbush which increased in size every growing season. Although some increase in shrub cover was measured on the north slopes, the persistence of perennial grasses, primarily western wheatgrass, was greater than on south slopes.

The population of annual species fluctuated widely, depending upon the available moisture. In 1977, during a severe drought, less than 1% ground cover by annual species was measured on any treatment. With greater precipitation in 1978 and 1979, vegetative cover increased, a large proportion of which was due to annual species which were mustard and cheatgrass.

Overall, the TOSCO retorted shale consistently supported less perennial vegetative cover than the USBM retorted shale, soil cover treatments, or the soil control. This was believed, in part, to be a reflection of the reduction in perennials caused by the resalinization in 1973 of the TOSCO profile after leaching. Measured surface temperatures indicated that evaporation of moisture from the black TOSCO material could have also significantly affected the vegetation. Runoff has also been greater on the TOSCO retorted shale due to the silty texture creating slow infiltration and resulting in less moisture recharge of the profile. All of these factors have probably contributed to less perennial vegetation cover on the TOSCO retorted shale.

Vegetative analysis by individual species is not presented or discussed here due to the voluminous amount of data. However, all measurements of individual species are reported in the appendix to this report.

Moisture in Retorted Shale and Soil Treatments

Patterns of moisture use for all treatments were plotted for 1976-1980 in Figures 3 through 6. Figures for 1979 were not included due to limited space, but all data for that year are reported in the appendix to this report. Maximum moisture content of the profiles originated primarily from spring snowmelt recharge. Depletion throughout the growing season by plants resulted in a minimal moisture content of profiles by fall. The soil moisture readings graphed for each year were made on the following dates:

	Spring	Fall
1976	April 1	August 4
1977	April 14	September 16
1978	April 4	September 13
1979	May 15	September 11
1980	April 15	September 13

Measurement of moisture content was made with a neutron probe. Therefore all values are in percent by volume. Readings at the 15 cm depth were probably unusally low because of neutron scatter and loss.

TABLE 6. VEGETATIVE COVER BY SPECIES CATEGORIES FOR THE LOW-ELEVATION STUDY TREATMENTS, 1976-1980.

Treatment	Species Categories	1976	1977	1978	1979	1980
		- - - - - -	- - - - - -	- - - - - % - - - - -	- - - - - -	- - - - - -
	NORTH ASPECT					
TOSCO Spent Shale	Perennial Grasses	28	21	33	16	12
	Shrubs	13	6	23	27	24
	Annuals	52	<1	55	29	15
15 cm Soil Cover/TOSCO	Perennial Grasses	73	28	52	45	36
	Shrubs	4	5	13	15	10
	Annuals	15	<1	43	25	12
30 cm Soil Cover/TOSCO	Perennial Grasses	53	25	44	42	29
	Shrubs	17	13	9	14	23
	Annuals	14	<1	5	30	13
USBM Spent Shale	Perennial Grasses	62	52	39	40	17
	Shrubs	14	10	15	17	33
	Annuals	17	<1	28	30	15
15 cm Soil Cover/USBM	Perennial Grasses	85	39	61	63	27
	Shrubs	16	16	16	28	19
	Annuals	1	<1	4	6	7
60 cm Soil Cover/USBM	Perennial Grasses	66	28	47	48	20
	Shrubs	24	12	30	41	30
	Annuals	7	<1	11	14	15
Soil Control	Perennial Grasses	78	28	65	53	31
	Shrubs	18	22	17	23	30
	Annuals	2	<1	10	20	10
	SOUTH ASPECT					
TOSCO Spent Shale	Perennial Grasses	23	8	6	12	6
	Shrubs	21	24	17	34	55
	Annuals	22	<1	35	6	32
15 cm Soil Cover/TOSCO	Perennial Grasses	66	14	30	37	13
	Shrubs	5	9	18	27	31
	Annuals	7	<1	28	22	20
30 cm Soil Cover/TOSCO	Perennial Grasses	45	13	17	17	7
	Shrubs	37	45	57	56	36
	Annuals	5	<1	15	10	23
USBM Spent Shale	Perennial Grasses	40	13	15	11	6
	Shrubs	21	32	47	50	34
	Annuals	11	<1	6	18	21
15 cm Soil Cover/USBM	Perennial Grasses	50	6	15	18	5
	Shrubs	23	21	40	52	50
	Annuals	6	<1	14	12	16
60 cm Soil Cover/USBM	Perennial Grasses	53	18	37	37	11
	Shrubs	24	31	31	26	44
	Annuals	3	<1	14	13	17
Soil Control	Perennial Grasses	79	16	40	56	21
	Shrubs	19	7	19	11	13
	Annuals	1	<1	22	10	13

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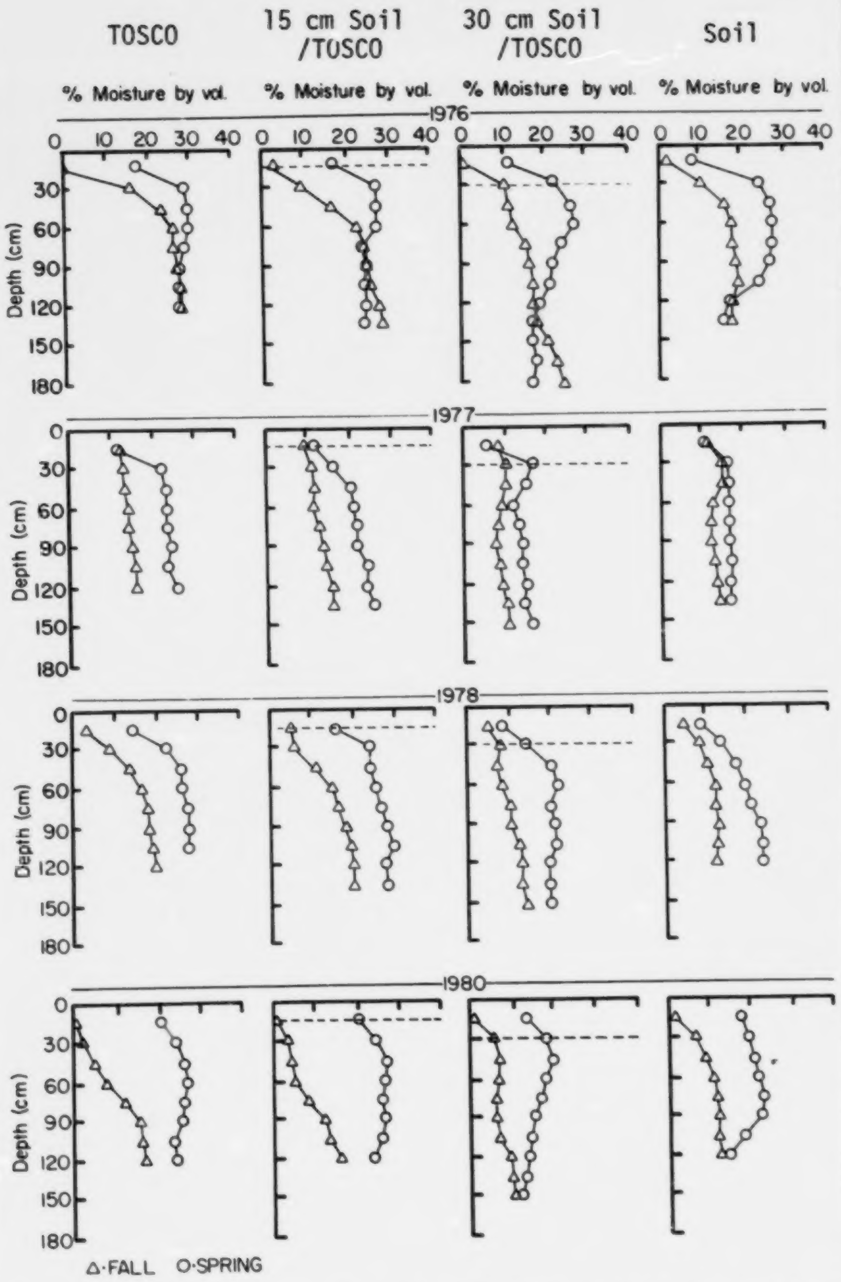

Figure 3. Seasonal moisture profiles for TOSCO retorted shale and soil treatments, north-aspect, low-elevation study, 1976-1980.

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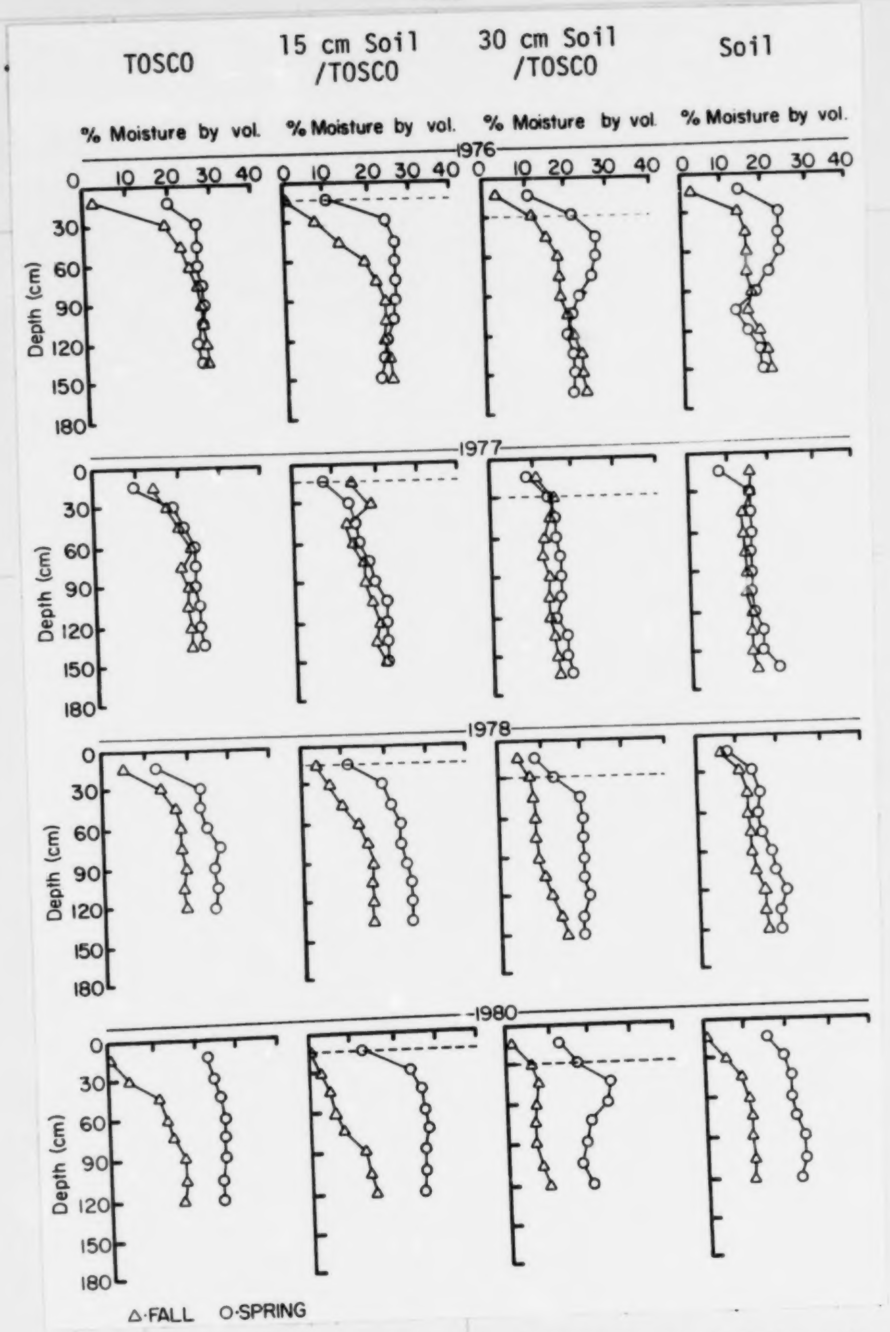

Figure 4. Seasonal moisture profiles for TOSCO retorted shale and soil treatments, south-aspect, low-elevation study, 1976-1980.

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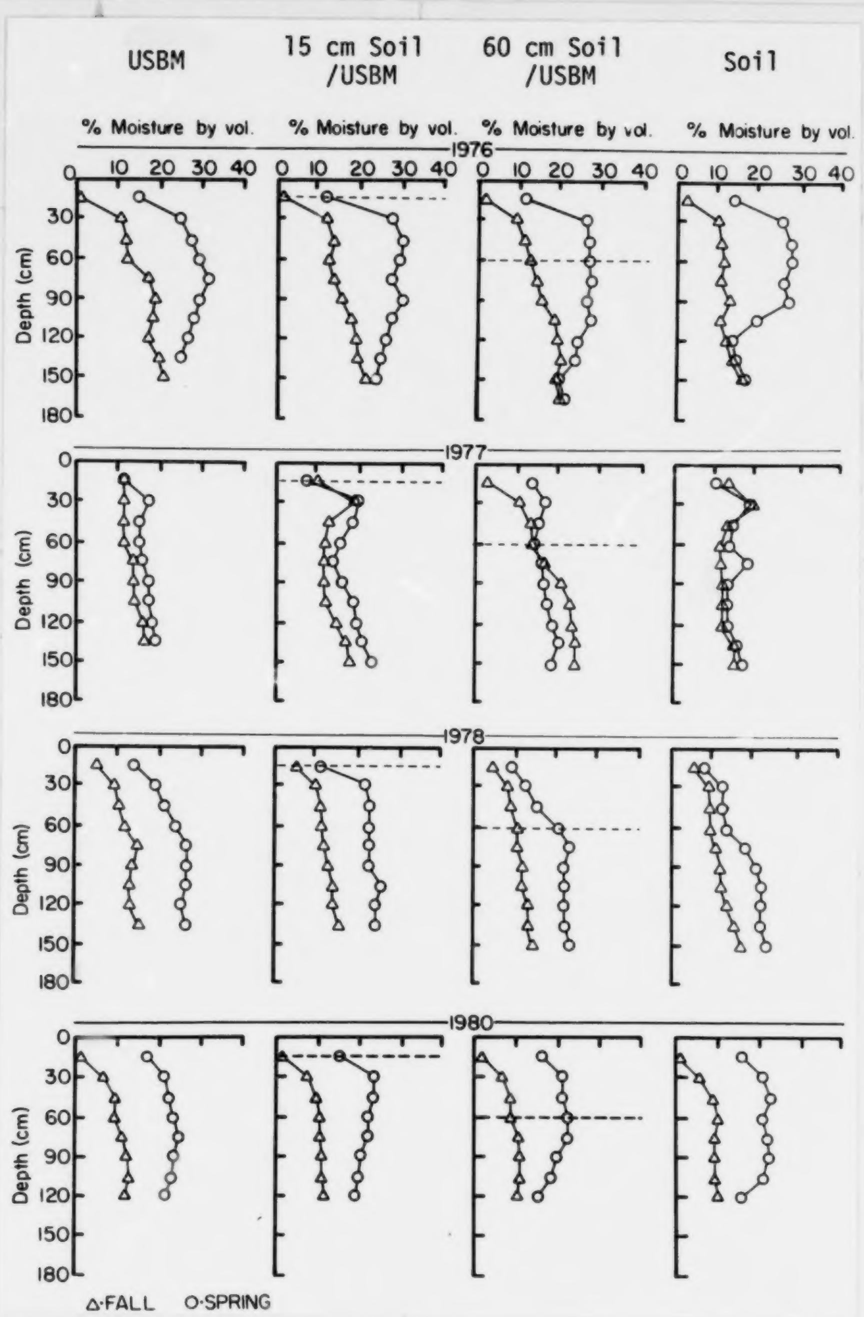

Figure 5. Seasonal moisture profiles for USBM retorted shale and soil treatments, north-aspect, low-elevation study, 1976-1980.

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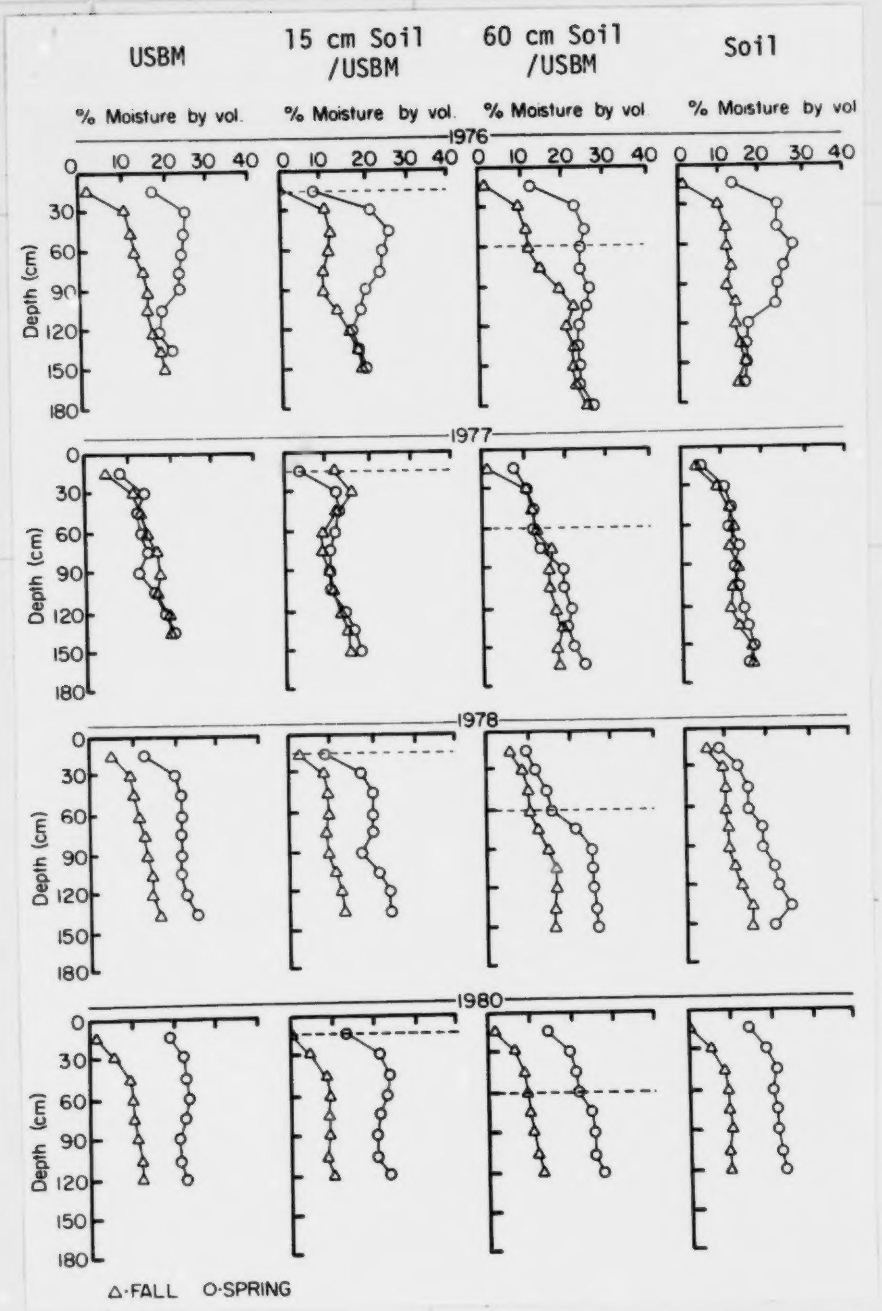

Figure 6. Seasonal moisture profiles for USBM retorted shale and soil treatments, south-aspect, low-elevation study, 1976-1980.

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Spring measurements in 1976 revealed a large reservoir of plant-available moisture in all treatments. Residual moisture from establishment irrigations was most likely responsible for the considerable amount of moisture measured (25% to 30% by volume). By fall, plant-available moisture was depleted to a depth of 90 cm to 120 cm, with moisture use greatest on the USBM retorted shale treatments. The least amount of water used was by plants growing on the TOSCO retorted shale.

Overwinter precipitation, from October of 1976 through the 1977 growing season, was considerably less than average for this study site. For this reason, recharge of the moisture profiles was minimal. In fact, the 1977 spring moisture profiles did not reveal significant differences from values measured in the fall of 1976 (12% to 20% moisture by volume). Consequently, plant-available water was limiting. The north-aspect of TOSCO retorted shale showed the most water lost throughout the growing season. Water losses were slight to insignificant on all other treatments.

With the return to more normal precipitation during the winter of 1977 and spring of 1978, recharge of the moisture profiles for all treatments averaged 25% moisture by volume. Water losses throughout the growing season were similar for both USBM and TOSCO treatments. The soil control showed the least amount of water lost, most probably due to the absence of fourwing saltbush on this treatment. This large spreading shrub had begun to dominate the vegetative composition of the retorted shale treatments, increasing the amount of water lost from moisture profiles during the growing seasons.

Patterns of recharge and depletion in the moisture profiles for 1979 measurements were very similar to 1978 values. In 1980, recharge from spring snowmelt averaged 20% to 25% moisture by volume, which, by the end of the growing season was depleted to approximately 10% moisture by volume. Once again, the soil control averaged the least amount of water lost from its profile, probably due to the lack of large shrubs on the treatment.

After seven growing seasons, the vegetative composition on these treatments is fairly stable. The large fourwing saltbush shrubs currently dominating the vegetation will most likely continue to extract substantial amounts of water from the moisture profiles of all treatments. If overwinter precipitation is average, the recharge and extraction patterns of both USBM and TOSCO retorted shales should continue to provide adequate plant-available moisture to support the present vegetative cover.

Leaching and Movement of Soluble Salts

Initial analysis of the retorted shales revealed high salinity levels, resulting in an unsuitable plant growth media. For this reason the retorted shales, and the 15-cm soil cover/retorted shales were leached prior to seeding. The treatments with 30 or 60 cm of soil cover/retorted shales, as well as the soil control, were not leached.

Soluble salt levels were determined by electrical conductivity (EC) measurements from core samples taken after leaching and in subsequent years

(Figure 7). In-place salinity sensors were also monitored, but, because of unreliable results, the data were not used in the following discussion. The EC values were obtained from 1:1 (soil to water by weight) extracts, and therefore, are not directly applicable to salinity standards commonly found in the literature. An approximate conversion to standard saturation paste extract values can be made by multiplying the EC value of the 1:1 extract by 2. A final EC value of 4 mmhos/cm or greater is generally considered saline, while extracts with EC values greater than 16 mmhos/cm are classified as extremely saline (Richards, 1954).

Soluble salts in the TOSCO retorted shale extracts, before leaching, averaged about 18 mmhos/cm (Table 1). Immediately after leaching in early 1973 the EC values fell to around 5 mmhos/cm, but due to a combination of factors, the profiles of the TOSCO retorted shale were resalinized by the fall of 1974 (Harbert and Berg, 1978). A large reservoir of subsurface moisture, the movement of that moisture along with dissolved salts upward, and rapid surface evaporation from the black material, combined to cause the resalinization. The concentration of salts at the shale surface was particularly noticeable, with EC values of shale extracts reaching 15 to 17 mmhos/cm. Soluble salts did not accumulate at the surface of the TOSCO shale treatments which had not been leached, because subsurface water in excess of field capacity was not available to transport dissolved salts upward.

Core samples taken in subsequent years indicated that additional moisture from winter and spring precipitation was effective in moving the soluble salts downward within the profile. Although, when sampled in 1978 there was a small overall increase in salinity throughout the entire profile of the TOSCO shale plots, this was likely due to leaching of soluble salts from large particles of the processed shale. Further precipitation and continued weathering of the shale particles resulted in an overall decrease of salinity throughout the entire profile of the TOSCO shales by 1980 (Figure 7). This, combined with a satisfactory vegetative cover, which effectively utilized moisture from the profile, should reduce the potential for upward movement of water and dissolved salts.

The salinity hazard of the USBM shale was initially less than the TOSCO shale, and after the 1973 leaching, has contined to remain at an acceptable level (Figure 7). Resalinization of the USBM shales did not occur, probably because of the coarse texture of this material, which restricted upward capillary movement.

The soil control was non-saline originally and no salt accumulation was observed during the study period.

One noteworthy item concerns the abundance of fourwing saltbush on the study plots. While this shrub is highly tolerant of saline conditions, and has continued to increase in size each year, it may also be capable of elevating soil salinity levels where it grows. It has been proposed that some *Atriplex* species can induce zones of salt depletion, accumulation, and compensation where grown (Sharma and Tongway, 1973). Future investigations should consider the effects that this shrub may have on revegetated areas.

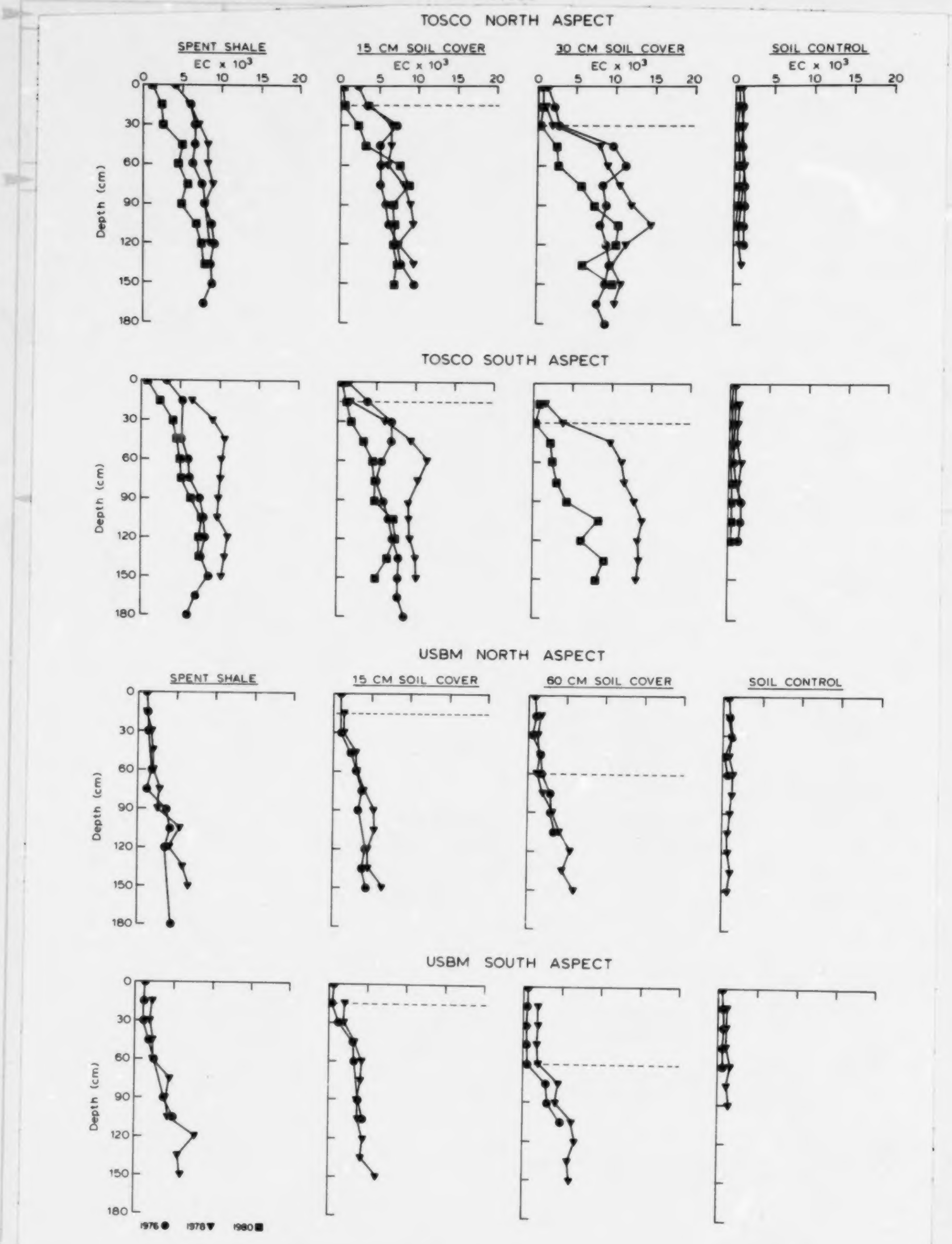

Figure 7. Soluble salt profiles of the low-elevation study treatments, 1976, 1978, 1980.

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Runoff and Water Quality

Surface runoff has primarily been the result of spring snowmelt, although occasional summer thunderstorms have resulted in measureable surface runoff. Volume of runoff, sediment yields, conductivity, and chemical analyses are reported in Tables 7 through 10, and summarized in the following discussion. Runoff and water quality data for the 1973-1976 period were reported in Harbert and Berg (1978).

Overwinter precipitation for 1976-1977 was severely limiting resulting in no measureable spring snowmelt runoff except for one north-aspect, 15-cm soil cover/TOSCO plot. Runoff calculated from this plot only amounted to 0.02 cm. In September of 1977 two separate summer thunderstorms produced limited runoff on a few treatment plots (Table 7). The only significant runoff was confined to the TOSCO retorted shales, and was ranked as posing a low salinity hazard. Sediment yields from the TOSCO shale treatments were highest but when compared to agricultural soils, were small. Caution must be used in interpreting these data as it has been observed that small amounts of runoff dissolved salts concentrated at the surface. Larger amounts of runoff simply diluted these salts, decreasing the salinity hazard of the runoff water.

1978 spring snowmelt produced runoff primarily restricted to the various TOSCO shale treatment plots (Table 8). With small amounts of runoff, the salinity hazard was rated moderate to high for most treatments. Sediment yields were considered minimal.

A larger amount of spring snowmelt runoff in 1979 was rated as having a low salinity hazard with nominal sediment yields (Table 9).

Spring snowmelt in 1980 produced runoff only on frozen north-aspect slopes. Because a thin layer of ice remained over the frozen ground, the water quality of the runoff posed no environmental hazard (Table 10).

The well-developed vegetative cover on all treatments at this site will most likely minimize excessive runoff and erosion in future seasons. Runoff from spring snowmelt will depend primarily upon whether the ground surface is frozen or thawed, but water quality from a frozen surface should not present environmental problems. This type of runoff will, however, limit the amount of moisture that infiltrates the profile to be used by vegetation later.

TABLE 7. SURFACE RUNOFF FROM TWO SUMMER STORMS FOR THE LOW-ELEVATION STUDY, 1977.

September 1, 1977

	TOSCO							
	North Aspect				South Aspect			
	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control
Total Runoff, cm	-	0.02	0.30	-	0.02	0.05	0.18	0.01
EC, μmhos/cm*	-	-	581	-	-	595	570	-
Salinity Hazard†	-	-	Low	-	-	Low	Low	-
Sediment Yield, kg/ha	-	-	70.14	-	-	7.97	98.26	-

	USBM							
	North Aspect				South Aspect			
	60 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control	60 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control
Total Runoff, cm	0.01	-	0.02	-	0.02	0.02	0.06	0.04
EC, μmhos/cm*	-	-	-	-	-	-	575	642
Salinity Hazard†	-	-	-	-	-	-	Low	Low
Sediment Yield, kg/ha	-	-	-	-	-	-	12.30	11.31

September 20, 1977

	TOSCO							
	North Aspect				South Aspect			
	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control
Total Runoff, cm	-	0.02	0.14	0.01	-	0.01	0.17	-
EC, μmhos/cm*	-	-	383	-	-	-	313	-
Salinity Hazard†	-	-	Low	-	-	-	Low	-
Sediment Yield, kg/ha	-	-	49.58	-	-	-	115.04	-

	USBM							
	North Aspect				South Aspect			
	60 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control	60 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control
Total Runoff, cm	0.01	-	-	-	-	-	0.04	-
EC, μmhos/cm*	-	-	-	-	-	-	-	-
Salinity Hazard†	-	-	-	-	-	-	-	-
Sediment Yield, kg/ha	-	-	-	-	-	-	-	-

* EC values are in μmhos/cm @ 25^{o}C

† Richards, 1954.

- No sample collected if less than 25 l in the primary collection container.

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TABLE 8. SPRING SNOWMELT RUNOFF FOR THE LOW-ELEVATION STUDY, APRIL 4, 1978.

TOSCO

	North Aspect				South Aspect			
	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control	30 cm Soil Cover	5 cm Soil Cover	Spent Shale	Soil Control
Total Runoff, cm	<0.1	<0.1	0.4	<0.1	0.2	0.2	0.2	<0.1
EC, μmhos/cm*	-	-	1210	-	3200	1550	2280	-
Salinity Hazard†	-	-	Med	-	V. high	High	High	-
pH	-	-	6.8	-	6.8	6.8	6.8	-
Sediment Yield, kg/ha	-	-	1.4	-	33.2	3.1	2.6	-

USBM

	North Aspect				South Aspect			
	60 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control	60 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control
Total Runoff, cm	<0.1	<0.1	0.1	0.1	<0.1	<0.1	0.2	0.1
EC, μmhos/cm*	-	-	1950	-	-	-	1400	1900
Salinity Hazard†	-	-	High	-	-	-	Med - high	High
pH	-	-	6.9	-	-	-	6.9	6.6
Sediment Yield, kg/ha	-	-	1.6	-	-	-	3.1	2.3

* EC values are in μmhos/cm @ 25°C

† Richards, 1954.

- No sample collected if less than 25 l in the primary collection container.

TABLE 9. SPRING SNOWMELT RUNOFF FOR THE LOW-ELEVATION STUDY, 1979. SAMPLES FROM SOUTH-ASPECT SLOPES WERE COLLECTED ON MARCH 16, 1979 AND NORTH-ASPECT SLOPES WERE COLLECTED ON APRIL 25, 1979.

TOSCO

	North Aspect				South Aspect			
	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control
Total Runoff, cm	0.27	0.43	0.86	0.09	1.37	0.88	1.44	0.50
EC, μmhos/cm*	283	224	334	-	521	283	420	130
Salinity Hazard†	Low	Low	Low	-	Low	Low	Low	Low
Sediment Yield, kg/ha	0.55	0.9	1.7	-	2.75	-	2.9	0.7

USBM

	North Aspect				South Aspect			
	60 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control	60 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control
Total Runoff, cm	0.37	0.13	0.66	0.06	0.62	1.05	1.02	0.67
EC, μmhos/cm*	499	411	210	-	367	291	358	330
Salinity Hazard†	Low	Low	Low	-	Low	Low	Low	Low
Sediment Yield, kg/ha	0.75	0.35	2.65	-	8.3	3.15	3.55	4.0

* EC values are in μmhos/cm @ 25°C

† Richards, 1954.

- No sample collected if less than 25 l in the primary collection container.

TABLE 10. SPRING SNOWMELT RUNOFF AND ANALYSES FROM THE NORTH-ASPECT OF THE LOW-ELEVATION STUDY, MARCH 26, 1980.

Treatment	North Aspect													
	60 cm Soil Cover USBM		15 cm Soil Cover USBM		USBM Spent Shale		Soil Control	30 cm Soil Cover TOSCO		15 cm Soil Cover TOSCO		TOSCO Spent Shale		Soil Control
	13	11	9	7	5	3	1	I	III	V	VII	IX	XI	XIII
Runoff (cm)	2.47	2.74	2.67	2.77	1.69	2.84	2.24	2.13	2.80	2.56	2.89	1.80	2.81	2.28
pH	6.8	7.0	7.2	7.2	7.0	6.9	6.8	7.0	6.8	6.9	7.0	7.2	7.0	7.0
EC (umhos/cm)*	190	120	90	90	140	130	100	100	190	80	140	140	130	90
Na (meq/l)	0.04	0.04	0.03	0.04	0.03	0.04	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.02
Ca (meq/l)	0.47	0.34	0.22	0.24	0.32	0.28	0.29	0.34	0.33	0.25	0.27	0.76	0.41	0.33
Mg (meq/l)	0.62	0.40	0.33	0.30	0.66	0.56	0.23	0.27	0.61	0.18	0.53	0.50	0.55	0.22
K (meq/l)	0.84	0.43	0.32	0.29	0.43	0.40	0.42	0.28	0.54	0.18	0.50	0.21	0.38	0.34
CO_3 (meq/l)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCO_3 (meq/l)	1.4	1.0	0.9	0.6	1.2	1.0	0.8	0.7	1.1	0.6	1.0	1.1	1.0	0.6
SO_4 (meq/l)	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.4	0.3	0.1
Cl (meq/l)	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SAR	0.05	0.06	0.06	0.07	0.05	0.07	0.06	0.04	0.05	0.06	0.04	0.03	0.04	0.04
Salinity hazard	low	low	low	low	low	low	low	low	low	low	low	low	low	low
Sodium hazard	low	low	low	low	low	low	low	low	low	low	low	low	low	low

No sample from south slopes due to lack of runoff.

* EC values are in umhos/cm @ 25 C

Surface Temperatures

Temperatures 1 cm below the surface of TOSCO shale and soil plots, for both north and south aspects were monitored during the 1978 growing season. Previous data (Harbert and Berg, 1978) had shown temperatures sufficiently high in late June and July on the TOSCO shale, south-aspect, to limit seedling establishment. The 1978 measurements continued to support these findings (Figure 8). Initial establishment of vegetation without the protection of a mulch could be difficult, and the successful germination of seedlings in continuing years might depend upon the shade provided by an adequate mature vegetative cover. Evaporative losses could also be substantial, creating a difficult revegetation site.

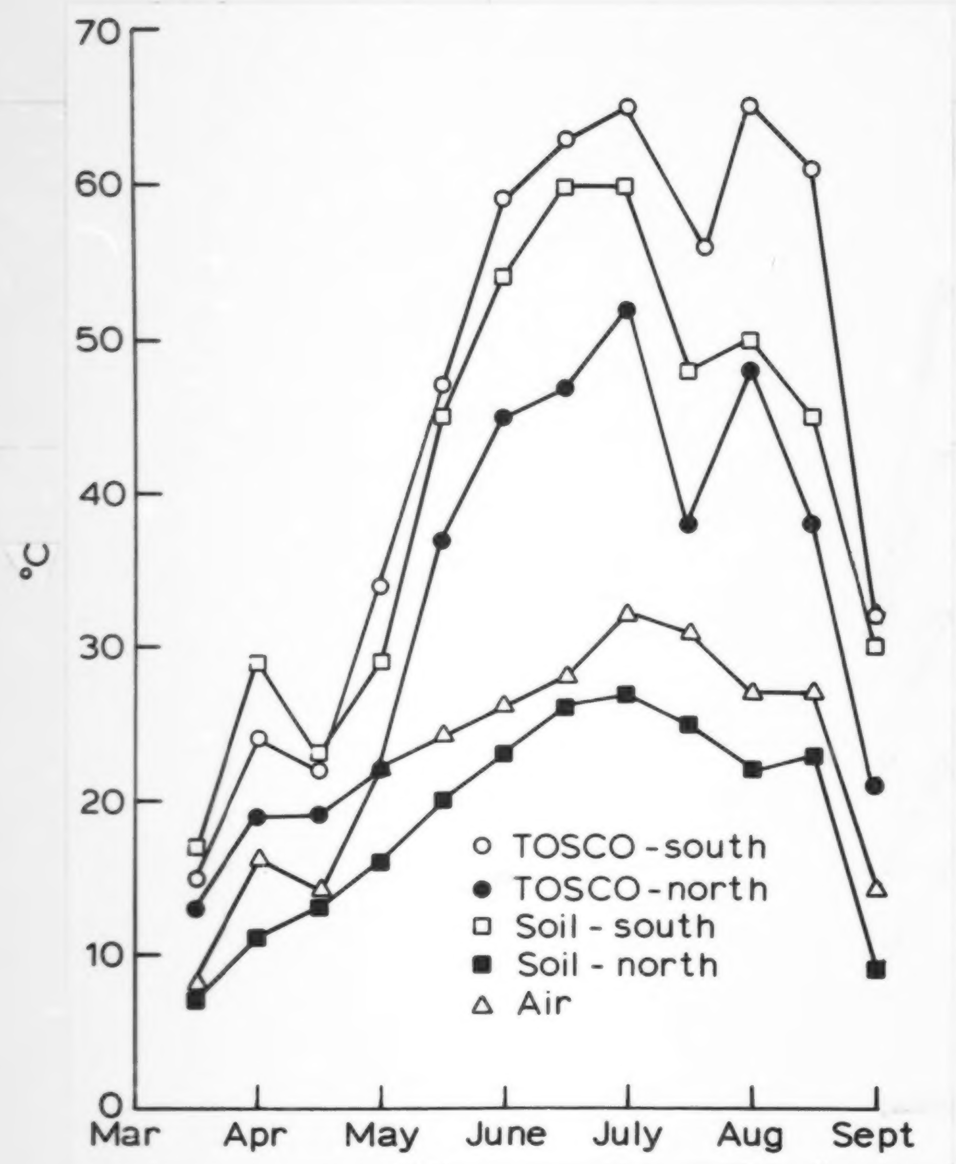

Figure 8. Maximum temperatures at 1 cm depth for TOSCO retorted shale and soil treatments at the low-elevation study, 1978.

HIGH-ELEVATION STUDY SITE

Vegetation

Because of ineffective leaching of some treatments in 1974, an unsatisfactory stand establishment resulted. All plots at this study site were releached, reseeded, and irrigated for establishment in 1975. Therefore, 1976 was the first growing season dependent upon natural precipitation, although it was likely that some moisture remained in the soil profile due to leaching. The seeding rate of western wheatgrass on both TOSCO and USBM retorted shales was doubled when the plots were reseeded in 1975. From the start, rodent activity on the north slopes of the 30-cm soil cover/USBM retorted shale caused disturbances that affected the vegetative cover on that treatment plot.

Initially, a satisfactory vegetative cover was established in 1975, with dense stands of western wheatgrass on the TOSCO and USBM retorted shales. This was probably due to the effective leaching and the doubled seeding rate of western wheatgrass.

Very little overwinter precipitation and an abnormally dry growing season in 1977 combined to reduce the vegetative cover on almost all treatments (Table 11). Shrubs endured the drought better than perennial grasses, the former actually increased on USBM retorted shale. Annual species dropped to less than 1% on all treatments due to lack of moisture (Table 12).

TABLE 11. VEGETATIVE COVER FOR THE HIGH-ELEVATION STUDY TREATMENTS, 1976-1980.

Treatment	1976	1977	1978	1979	1980
			%		
TOSCO Spent Shale	84	61	63	61	38
15 cm Soil Cover/TOSCO	83	52	69	73	34
30 cm Soil Cover/TOSCO	77	51	62	75	41
USBM Spent Shale	81	60	62	71	57
15 cm Soil Cover/USBM	73	52	78	78	46
30 cm Soil Cover/USBM	66	43	70	80	51
Soil Control	79	47	67	80	43

In the fall of 1977, cattle accidentally entered the study site and grazed much of the vegetation. Because of adequate moisture for plant regrowth, the overall 1978 vegetative cover was not severely reduced, despite heavy grazing of fourwing saltbush. With more moisture, annual species were measured in modest amounts, particularly on the soil control.

Another season of sufficient moisture increased the vegetative cover on almost all treatments in 1979. Unfortunately a large amount of this increase was due to the invasion of annual species such as cheatgrass and mustard (Table 12). The increase of annuals may have also been aided by the shift from a population of mainly perennial grasses to one increasingly dominated by shrubs. This transition was especially noticeable on the USBM retorted shales where rodent disturbances also allowed the invasion of annuals.

During the 1980 growing season rodent activity increased, disturbing large areas of many treatment plots and resulting in an overall decrease of vegetative cover (Table 11). Most of this decrease was attributable to the loss of perennial grasses on many treatments (Table 12). The invasion of weedy species also accompanied this disturbance.

Generally, for the years discussed, the overall vegetative cover for both TOSCO and USBM shales was comparable to the soil control. In retrospect, the doubled seeding rate of western wheatgrass on those two treatments provided an initial cover which exceeded that of the soil control. After a severe drought season in 1976-1977, vegetation on both shale treatments recovered well. However, the species composition of the shale treatments supported a much greater proportion of cover as shrubs than the soil control, a trend which is expected to continue in future growing seasons.

Moisture in Retorted Shale and Soil Treatments

Spring snowmelt generally provided a maximum moisture recharge of treatment profiles. During the growing season vegetation extracted plant-available moisture from the treatment profiles resulting in a depletion by fall. Neutron probe measurements taken on the following dates were used to graph spring recharge and fall depletion values.

Year	Spring	Fall
1976	March 31	August 12
1977	April 26	September 14
1978	May 16	September 13
1979	May 15	September 11
1980	April 16	September 13

Figures for 1979 were not included due to limited space, but all data for that year are reported in the appendix to this report.

Moisture profiles of almost all treatments in 1976 contained residual moisture from 1975 irrigation applications (Figures 9 through 12). One exception seemed to be the USBM treatments on north slopes. Very little recharge from spring snowmelt occurred because of the high surface runoff for these plots (Harbert and Berg, 1978). In fact, precipitation during the 1976 growing season, combined with a less than average vegetative cover, produced an overall increase in plant-available water by the fall of 1976 (Figures 9 through 12).

TABLE 12. VEGETATIVE COVER BY SPECIES CATEGORIES FOR THE HIGH-ELEVATION STUDY SITE, 1976-1980.

Treatment	Species Categories	1976	1977	1978	1979	1980
				%		
	NORTH ASPECT					
TOSCO Spent Shale	Perennial Grasses	68	38	43	44	22
	Shrubs	21	12	9	33	18
	Annuals	6	<1	12	0	<1
15 cm Soil Cover/TOSCO	Perennial Grasses	48	42	52	59	26
	Shrubs	13	7	21	22	11
	Annuals	7	<1	2	3	1
30 cm Soil Cover/TOSCO	Perennial Grasses	40	38	54	47	33
	Shrubs	9	<1	9	3	2
	Annuals	7	<1	5	32	11
USBM Spent Shale	Perennial Grasses	60	40	24	21	6
	Shrubs	20	30	32	51	48
	Annuals	2	<1	3	7	5
15 cm Soil Cover/USBM	Perennial Grasses	48	44	56	35	12
	Shrubs	7	10	23	38	31
	Annuals	11	<1	2	7	1
30 cm Soil Cover/USBM	Perennial Grasses	29	42	42	29	9
	Shrubs	13	12	24	34	28
	Annuals	17	<1	7	29	12
Soil Control	Perennial Grasses	41	38	43	41	26
	Shrubs	16	12	9	14	9
	Annuals	14	<1	12	44	11
	SOUTH ASPECT					
TOSCO Spent Shale	Perennial Grasses	61	49	31	28	16
	Shrubs	16	23	23	30	14
	Annuals	2	<1	<1	0	17
15 cm Soil Cover/TOSCO	Perennial Grasses	45	39	45	54	19
	Shrubs	12	15	15	21	14
	Annuals	4	<1	<1	0	1
30 cm Soil Cover/TOSCO	Perennial Grasses	42	38	41	40	9
	Shrubs	23	23	10	11	29
	Annuals	7	<1	8	30	2
USBM Spent Shale	Perennial Grasses	41	21	24	16	3
	Shrubs	32	37	36	43	49
	Annuals	3	<1	<1	0	14
15 cm Soil Cover/USBM	Perennial Grasses	39	38	40	21	6
	Shrubs	16	17	27	38	40
	Annuals	16	<1	8	30	11
30 cm Soil Cover/USBM	Perennial Grasses	28	26	39	17	5
	Shrubs	24	19	17	31	39
	Annuals	18	<1	3	34	19
Soil Control	Perennial Grasses	28	25	42	24	9
	Shrubs	22	17	14	16	13
	Annuals	19	<1	12	52	19

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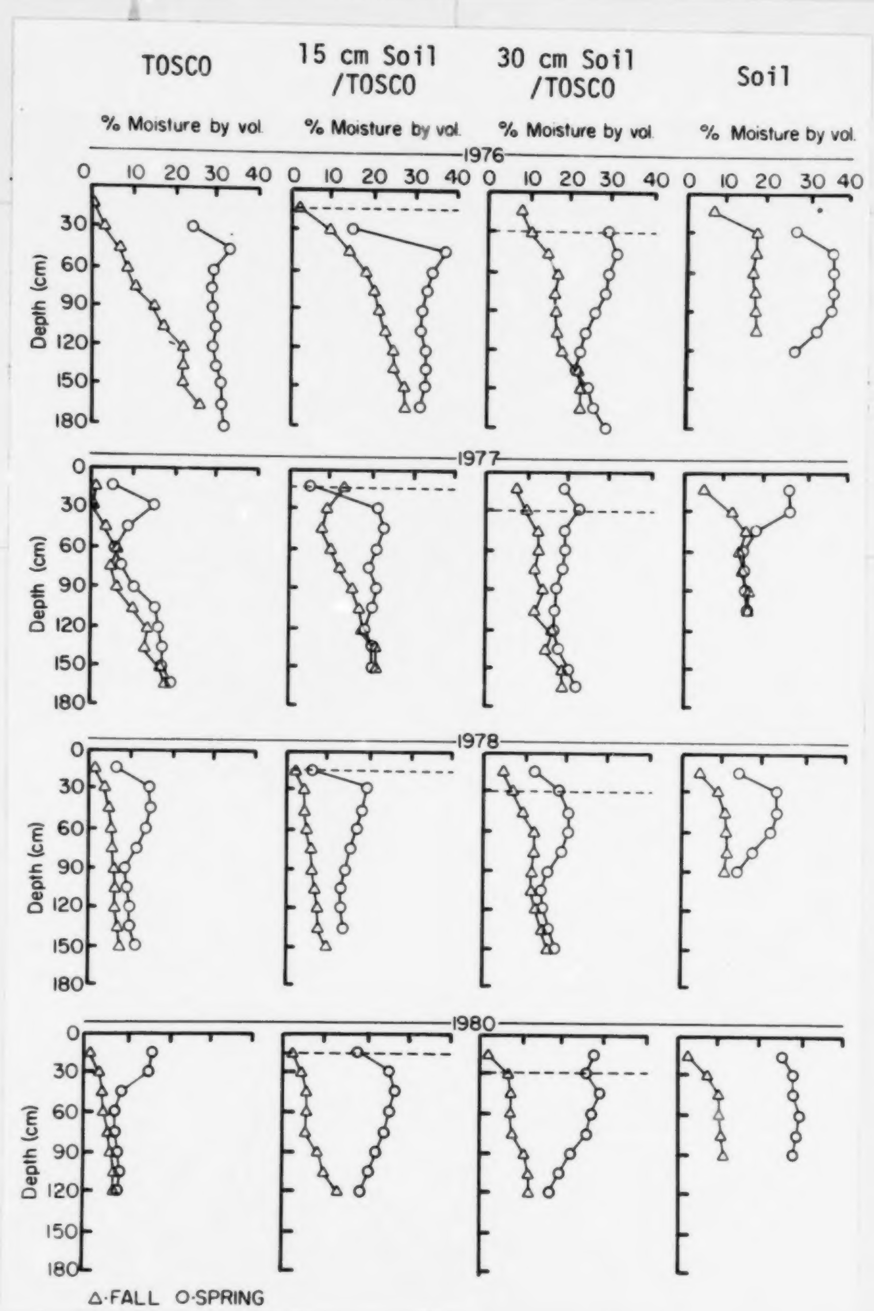

Figure 9. Seasonal moisture profiles for TOSCO retorted shale and soil treatments, north-aspect, high-elevation study, 1976-1980.

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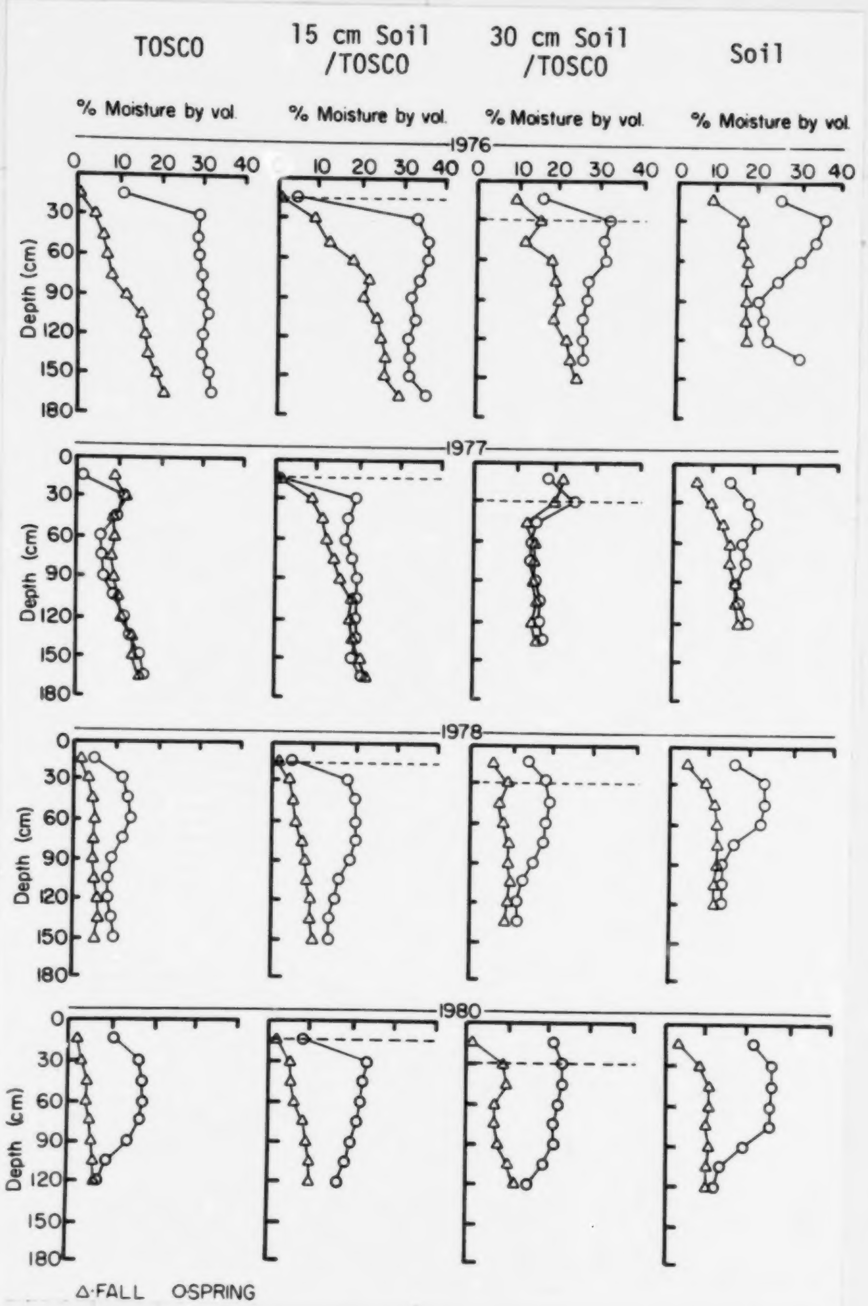

Figure 10. Seasonal moisture profiles for TOSCO retorted shale and soil treatments, south-aspect, high-elevation study, 1976-1980.

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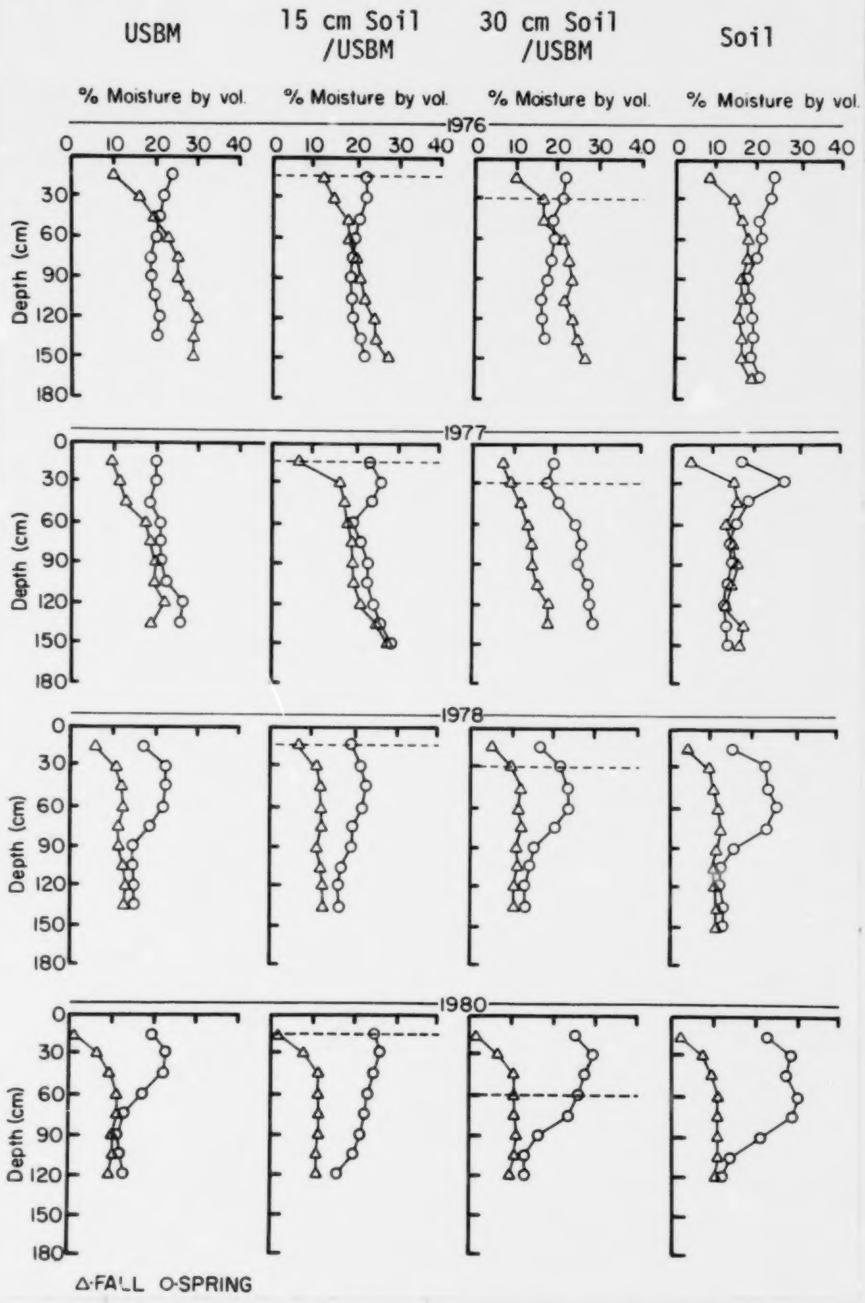

Figure 11. Seasonal moisture profiles for USBM retorted shale and soil treatments, north-aspect, high-elevation study, 1976-1980.

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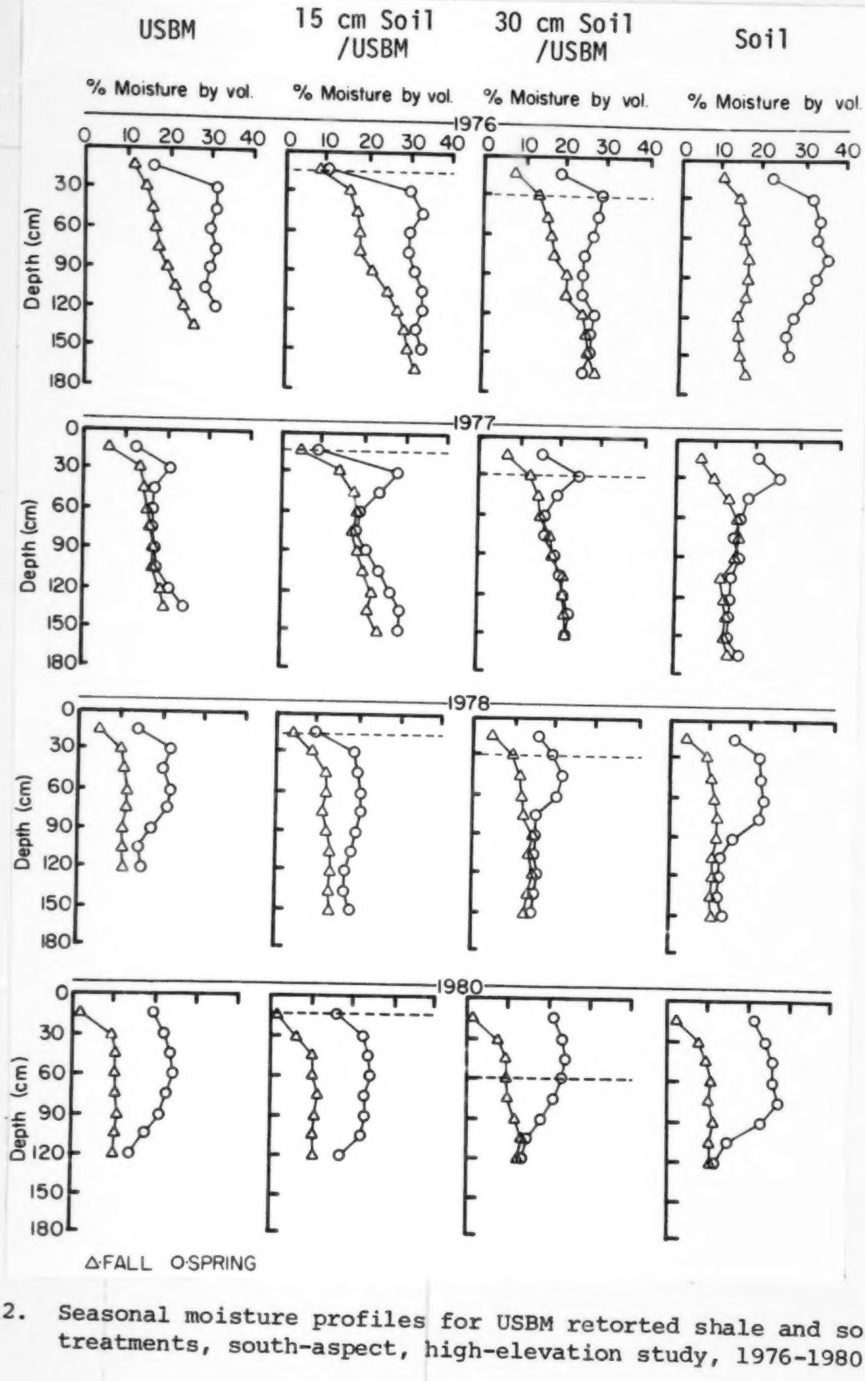

Figure 12. Seasonal moisture profiles for USBM retorted shale and soil treatments, south-aspect, high-elevation study, 1976-1980.

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Very limited overwinter precipitation, from October 1976 through March 1977, resulted in a minimal spring recharge of moisture profiles. Averages from 10% to 20% moisture by volume indicated that spring 1977 values were not appreciably greater than fall 1976 measurements. Because of the lack of plant-available water, vegetative growth on almost all treatments suffered, resulting in very little water loss throughout the profile.

Although precipitation for the 1977-1978 winter period was below average, spring recharge for 1978 averaged approximately 20% by volume for USBM treatments. Most of these treatments were recharged to a depth of 90 cm. The TOSCO retorted shale averaged only 10% to 15% moisture by volume to 60 cm depths. This may be a reflection of the higher surface runoff from the latter treatments (Table 14). Spring recharge was greatest on the soil control, averaging 20% to 25% moisture by volume. Water loss throughout the growing season was also greater on the soil control resulting in only about 10% moisture by volume remaining in the profile by fall of 1978. Moisture extraction patterns on all other treatments were similar.

Near average precipitation permitted a 1979 spring recharge of 20% to 25% soil moisture by volume on all treatments. Large amounts of runoff from a TOSCO retorted shale, south-aspect, plot did not seem to adversely affect spring recharge. Once again the soil control averaged the highest spring soil moistures, and the most water lost from the profile through the growing season. Moisture measurements taken in the fall of 1979 indicated depletion to approximately 10% on most treatments, while the TOSCO retorted shale averaged 6% moisture by volume.

Seasonal moisture profiles for 1980 followed much the same patterns as in previous years. Recharge from a greater than average snowfall brought most treatments to 20% to 30% moisture by volume capacity to depths of 60 cm to 90 cm.

Overall, it appeared that moisture recharge by spring snowmelt was significantly affected by the fine-textured TOSCO material, due to high runoff rates. The coarser textured USBM shale allowed faster infiltration of snowmelt which resulted in greater spring moisture levels.

Leaching and Movement of Soluble Salts

Core samples taken after leaching of the retorted shales and 15-cm soil cover/retorted shales in the fall of 1973 indicated that a reduction of salinity had not occurred. The leaching technique used was ineffective because the application of the irrigation water did not exceed the surface evaporation, to the extent that soluble salts were moved a satisfactory depth in the profile. In the spring of 1974 all previously leached treatments were releached to decrease the salinity hazard of the shale. Resalinization of the TOSCO retorted shales once again occurred, primarily at the shale surface. Another application of leach water was made to all leached treatments in the spring of 1975. Core samples after leaching indicated that effective leaching had occurred throughout the profile with accompanying EC values of less than 5 mmhos/cm (Figure 13).

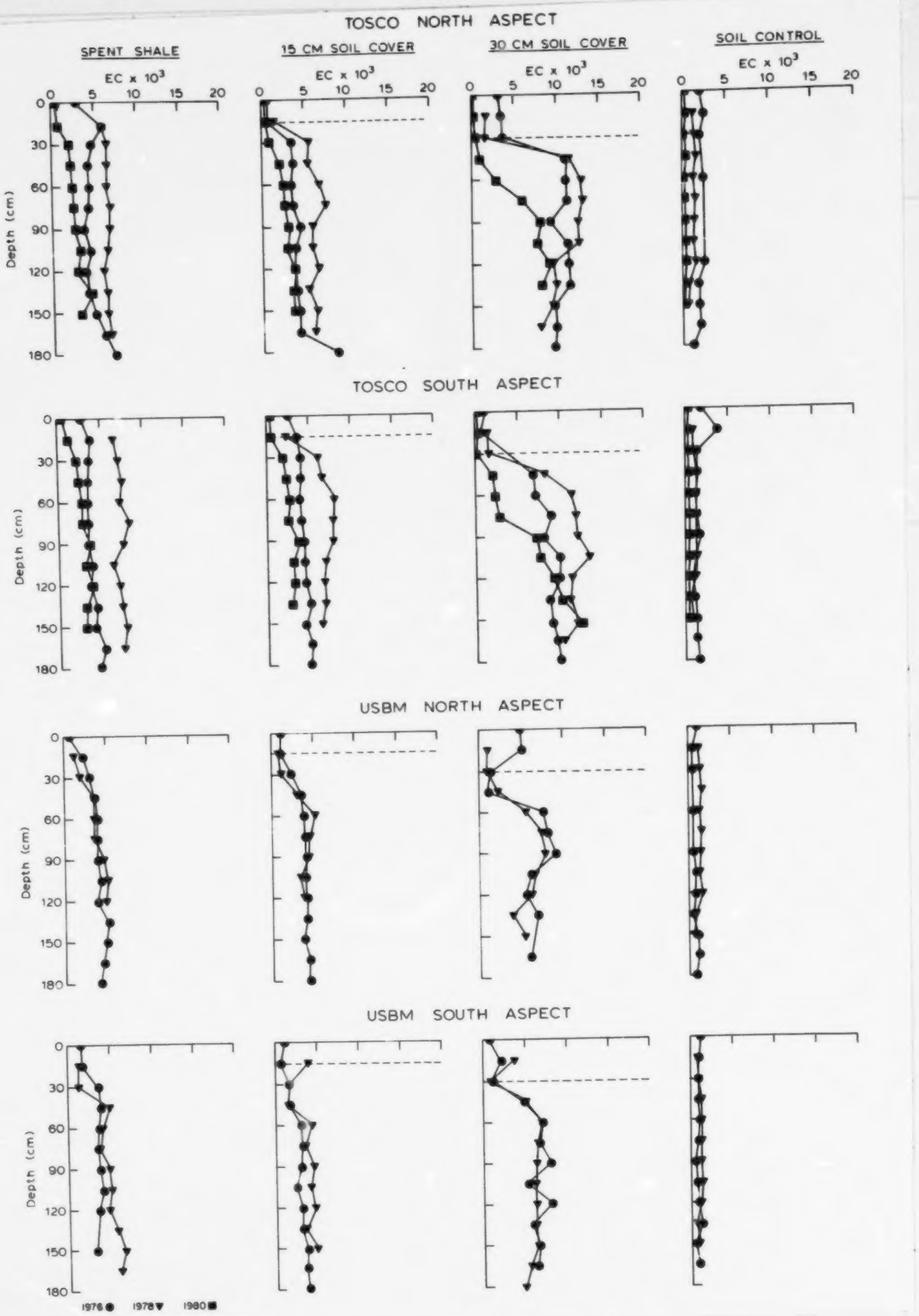

Figure 13. Soluble salt profiles of the high-elevation study treatments, 1976, 1978, 1980.

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The TOSCO shale treatments covered with 30 cm of soil were never leached, and therefore, continued to maintain a higher salinity level than the leached treatments.

Core samples taken in 1978 suggested that the TOSCO shale treatments had become slightly more saline with time, although shale extracts only averaged about 5 to 7 mmhos/cm in the leached treatments, and 10 to 12 mmhos/cm in the unleached treatments. This increase was most likely due to the leaching of soluble salts from within shale particles.

Increased weathering of the shale materials, combined with seasonal precipitation resulted in an overall decrease of salinity throughout the entire profile of the TOSCO shales by 1980 (Figure 13). Of particular interest was the downward movement of soluble salts in the 30-cm soil/unleached TOSCO shale treatments.

The USBM shale extract values were initially less saline than the TOSCO shale material, and with additional leaching have become acceptable with no indication of resalinization in succeeding years. Little or no change was observed in the salinity status of the soil control throughout the study.

Yearly precipitation and the rapid removal of subsurface water by the established vegetation cover should limit any upward resalinization. Since fourwing saltbush comprises a large proportion of the vegetative cover at this study site, the effect of this shrub on the soil or shale beneath the plant should be considered. Other studies have indicated that the litter from this shrub could increase the salinity of the surface horizon (Sharma and Tongway, 1973).

Runoff and Water Quality

All runoff and water quality data for the 1974-1976 period of study were reported in Harbert and Berg (1978). Runoff, sediment yield, conductivity, and chemical analyses for 1977-1980 measurements are found in Tables 13 through 16.

Runoff in the spring of 1977 was confined to the north aspect slopes of all treatments. This was mainly a reflection of the very limited overwinter precipitation for this year. In August of 1977 a thunderstorm produced small amounts of runoff on almost all treatment plots, ranging from 0.02 to 0.12 cm (Table 13). Salinity hazard was low for most treatments, but the TOSCO retorted shale runoff was rated as medium to high. One USBM retorted shale plot also produced runoff with a high salinity. Due to the small amount of runoff, surface salts were dissolved and removed by the initial runoff. Without additional runoff to dilute this concentrated salt solution, salinity hazards were high. This was clearly illustrated by the 1978 spring snowmelt runoff and analyses. Runoff from both USBM and TOSCO shale south slopes was minimal in quantity but had a very high salinity hazard. Whereas runoff from the north slopes of these two treatments was approximately three times the volume, but the salinity hazard was considerably less (Table 14).

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TABLE 13. SURFACE RUNOFF FROM SPRING SNOWMELT AND A SUMMER STORM FOR THE HIGH-ELEVATION STUDY, 1977.

March 24, 1977

	TOSCO							
	North Aspect				South Aspect			
	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control
Total Runoff, cm	0.40	0.90	0.53	0.22	-	-	-	-
EC, μmhos/cm*	410	195	295	835	-	-	-	-
Salinity Hazard†	Low	Low	Low	Med				
Sediment Yield, kg/ha	-	-	-	-	-	-	-	-

	USBM							
	North Aspect				South Aspect			
	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control
Total Runoff, cm	0.11	0.44	0.30	0.04	-	-	-	-
EC, μmhos/cm*	210	220	910	270	-	-	-	-
Salinity Hazard†	Low	Low	Med	Low	-	-	-	-
Sediment Yield, kg/ha	-	-	-	-	-	-	-	-

August 31, 1977

	TOSCO							
	North Aspect				South Aspect			
	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control
Total Runoff, cm	0.06	0.06	0.02	0.03	0.11	0.12	0.05	0.10
EC, μmhos/cm*	448	393	1,300	465	430	423	1,425	435
Salinity Hazard†	Low	Low	Med - high	Low	Low	Low	Med - high	Low
Sediment Yield, kg/ha	15.45	10.74	38.71	37.71	84.79	82.37	148.32	75.66

	USBM							
	North Aspect				South Aspect			
	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control
Total Runoff, cm	0.05	0.03	0.03	0.02	0.11	0.05	0.02	0.06
EC, μmhos/cm*	375	420	2,150	-	585	473	650	490
Salinity Hazard†	Low	Low	High	-	Low	Low	Low	Low
Sediment Yield, kg/ha	51.64	29.02	23.98	-	167.35	66.97	7.53	67.45

* EC values are in μmhos/cm @ 25°C

† Richards, 1954.

- No sample collected if less than 25 l in the primary collection container.

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TABLE 14. SPRING SNOWMELT RUNOFF FOR THE HIGH-ELEVATION STUDY, APRIL 6, 1978.

	TOSCO							
	North Aspect				South Aspect			
	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control
Total Runoff, cm	1.7	1.5	2.3	1.0	0.6	0.6	0.8	0.2
EC, μmhos/cm*	1030	1230	1880	990	2100	2280	7200	2400
Salinity Hazard†	Med	Med - high	High	Med	High	High-v.high	V. high	High
pH	7.6	7.4	7.0	7.6	7.2	7.1	6.9	7.0
Sediment Yield, kg/ha	158.9	106.0	199.4	12.1	21.7	30.5	50.0	3.9

	USBM							
	North Aspect				South Aspect			
	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control
Total Runoff, cm	2.2	2.5	2.3	2.2	0.4	0.2	0.3	0.2
EC, μmhos/cm*	1010	810	1120	810	2480	2200	3180	2200
Salinity Hazard†	Med	Med	Med - high	Med	High-v.high	High	V. high	High
pH	7.0	6.9	7.0	6.8	7.1	7.1	7.1	7.0
Sediment Yield, kg/ha	75.0	103.5	51.9	13.3	25.3	14.2	17.4	7.0

* EC values are in μmhos/cm @ 25°C

† Richards, 1954

- No sample collected if less than 25 l in the primary collection container.

TABLE 15. SPRING SNOWMELT RUNOFF FOR THE HIGH-ELEVATION STUDY, APRIL 24, 1979.

	TOSCO							
	North Aspect				South Aspect			
	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control
Total Runoff, cm	0.26	0.36	1.43	0.28	0.64	0.41	2.75	0.61
EC, μmhos/cm*	87	181	60	-	164	132	286	154
Salinity Hazard†	Low	Low	Low	-	Low	Low	Low	Low
Sediment Yield, kg/ha	1.25	1.23	9.47	-	4.45	3.29	27.39	6.13

	USBM							
	North Aspect				South Aspect			
	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control	30 cm Soil Cover	15 cm Soil Cover	Spent Shale	Soil Control
Total Runoff, cm	0.09	0.10	0.25	0.22	0.99	0.43	0.49	0.44
EC, μmhos/cm*	-	220	100	157	267	172	169	163
Salinity Hazard†	-	Low	Low	Low	Low	Low	Low	Low
Sediment Yield, kg/ha	-	1.07	0.94	0.87	18.05	2.98	1.89	2.64

* EC values are in μmhos/cm @ 25°C

† Richards, 1954.

- No sample collected if less than 25 l in the primary collection container.

TABLE 16. SPRING SNOWMELT AND ANALYSES FOR THE HIGH-ELEVATION STUDY, 1980. SAMPLES FROM THE SOUTH-ASPECT SLOPES WERE COLLECTED ON APRIL 16, 1980 AND THE NORTH-ASPECT SLOPES WERE COLLECTED ON APRIL 29, 1980.

North Aspect

Treatment	30 cm Soil Cover USBM		15 cm Soil Cover USBM		USBM Spent Shale		Soil Control	30 cm Soil Cover TOSCO		15 cm Soil Cover TOSCO		TOSCO Spent Shale		Soil Control
	13	11	9	7	5	3	1	I	III	V	VII	IX	XI	XIII
Runoff (cm)	0.62	1.77	2.09	2.52	2.13	0.05	0.20	0.66	0.54	1.05	0.61	2.03	2.32	*
pH	6.3	6.3	6.1	6.5	6.3	6.3	6.5	6.4	6.1	6.2	6.4	6.1	6.0	*
EC (umhos/cm)⁺	280	300	170	150	310	480	120	120	110	210	130	170	200	*
Na (meq/l)	0.07	0.10	0.04	0.10	0.10	0.10	0.04	0.04	0.03	0.08	0.03	0.03	0.05	*
Ca (meq/l)	0.7	0.9	0.6	0.7	0.6	0.8	0.6	0.7	0.5	1.0	0.7	0.8	0.7	*
Mg (meq/l)	0.[illegible]	0.7	0.5	0.4	1.0	1.2	0.2	0.3	0.2	0.5	0.3	0.3	0.5	*
K (meq/l)	1.2	1.2	0.5	0.4	1.5	2.8	0.2	0.3	0.3	0.4	0.3	0.3	0.7	*
CO_3 (meq/l)	0	0	0	0	0	0	0	0	0	0	0	0	0	*
HCO_3 (meq/l)	1.7	1.8	1.1	1.2	2.1	3.0	0.8	0.9	0.7	1.5	1.0	0.9	1.3	*
Cl (meq/l)	1.1	1.4	0.5	0.3	0.9	1.5	0.1	0.4	0.3	0.6	0.4	0.4	0.7	*
SO_4 (meq/l)	0.3	0.2	0.2	0.1	0.2	0.7	0.7	0.1	0.04	0.2	0.1	0.5	0.2	*
SAR	0.09	0.11	0.06	0.07	0.11	0.10	0.07	0.05	0.06	0.09	0.05	0.03	0.07	*
Salinity hazard	low	low	low	low	low	low	low	low	low	low	low	low	low	*
Sodium hazard	low	low	low	low	low	low	low	low	low	low	low	low	low	*

SOUTH ASPECT

Treatment	30 cm Soil Cover USBM		15 cm Soil Cover USBM		USBM Spent Spent		Soil Control	30 cm Soil Cover TOSCO		15 cm Soil Cover TOSCO		TOSCO Spent Shale		Soil Control
	14	12	10	8	6	4	2	II	IV	VI	VIII	X	XIII	XIV
Runoff (cm)	1.73	0.30	0.38	1.01	0.25	0.31	0.60	2.27	2.37	1.46	2.72	2.37	2.08	0.43
pH	7.1	7.2	7.3	7.2	7.1	7.0	7.2	7.6	7.2	7.2	7.2	7.6	7.1	7.3
EC (umhos/cm)⁺	360	410	260	320	480	300	180	240	240	210	260	310	450	190
Na (meq/l)	0.2	0.2	0.1	0.2	0.4	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1
Ca (meq/l)	1.9	2.0	1.2	1.3	1.3	0.8	0.8	1.3	1.5	1.3	1.6	1.8	2.4	1.0
Mg (meq/l)	0.8	1.1	0.8	1.0	2.1	1.1	0.4	0.6	0.6	0.6	0.9	0.6	1.1	0.5
K (meq/l)	0.7	0.9	0.6	0.8	1.2	0.8	0.4	0.4	0.3	0.3	0.1	0.5	0.9	0.3
CO_3 (meq/l)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCO_3 (meq/l)	2.7	2.8	1.8	2.5	3.7	2.3	1.3	2.0	2.0	1.9	2.4	1.7	2.6	1.5
Cl (meq/l)	0.4	0.8	0.2	0.1	0.3	0.2	0.1	0.3	0.2	0.1	0.1	0.2	0.3	0.1
SO_4 (meq/l)	0.3	0.5	0.3	0.4	0.6	0.4	0.1	0.1	0.1	0.2	0.2	1.0	2.3	0.3
SAR	0.17	0.16	0.10	0.19	0.31	0.21	0.13	0.10	0.10	0.10	0.18	0.09	0.08	0.12
Salinity hazard	low	low	low	low	low	low	low	low	low	low	low	low	low	low
Sodium hazard	low	low	low	low	low	low	low	low	low	low	low	low	low	low

* No sample collected due to lack of runoff.

⁺ EC values are in umhos/cm @ 25 C

Sediment yields were considered negligible when compared to regional sediment yields mapped by the Soil Conservation Service.

1979 spring snowmelt runoff had low salinity hazard, minimal runoff, and small sediment yields.

1980 spring runoff was generally small in volume and rated low with respect to salinity hazard, sodium hazard, or sediment yield.

At present, runoff, erosion, and salinity hazards from the treatments are within acceptable levels. The most critical environmental factor appears to be the salinity hazard of small amounts of runoff from the retorted shale. This type of runoff is associated with limited snowmelt runoff or summer thunderstorm activity typical of this region. As far as revegetation efforts, the spring snowmelt runoff poses a problem in that moisture from snowmelt that runs off does not enter the shale or soil profile, and therefore is not available for plant growth needs. The satisfactory vegetative cover on most treatments minimized runoff and erosion. The increased rodent activity causing surface disturbance may develop the potential for greater runoff and erosion.

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APPENDIX TABLES

APPENDIX TABLE 1. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE TOSCO SHALE TREATMENTS, NORTH-ASPECT, LOW-ELEVATION STUDY SITE, 1977.

	30 cm Soil Cover/TOSCO						15 cm Soil Cover/TOSCO						TOSCO Spent Shale						Soil Control		
	I			III			V			VII			IX			XI			XIII		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
PERENNIAL GRASSES																					
Western wheatgrass	-	135*	156	44	54	58	84	46	83	62	58	94	18	77	56	83	40	80	27	46	58
Bluebunch wheatgrass	-	-	-	-	-	39	-	11	32	-	17	83	-	18	4	15	24	16	17	33	39
Indian ricegrass	-	-	26	-	-	-	-	-	-	-	-	-	-	-	-	-	6	1	-	-	-
SHRUBS																					
Winterfat	12	-	-	10	6	-	22	9	-	6	9	-	-	-	-	9	11	19	-	-	8
Fourwing saltbush	75	-	3	135	39	-	-	-	-	-	57	-	51	-	-	-	-	28	180	168	-
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FORBS																					
Scarlet globemallow	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-
Penstemon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
OTHER SPECIES																					
Russian thistle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-
NO VEGETATIVE COVER	83	40	20	55	50	33	39	6	9	33	26	22	104	13	41	88	13	13	-	-	19
LITTER	109	249	52	36	147	99	142	57	130	239	88	66	90	111	67	98	71	88	160	167	-
STANDING LITTER	135	72	89	66	48	117	53	222	79	95	84	75	42	97	163	26	166	95	48	76	202

* Values are total cm of above ground vegetative cover by species. Transect lines averaged 350 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 2. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE TOSCO SHALE TREATMENTS, SOUTH-ASPECT, LOW-ELEVATION STUDY SITE, 1977.

	30 cm Soil Cover/TOSCO						15 cm Soil Cover/TOSCO						TOSCO Spent Shale						Soil Control		
	II			IV			VI			VIII			X			XII			XIV		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
PERENNIAL GRASSES																					
Western wheatgrass	22*	33	59	22	27	51	52	31	31	47	24	46	6	22	13	15	45	-	54	135	26
Bluebunch wheatgrass	-	-	12	-	-	29	-	13	-	-	11	28	-	-	-	-	-	228	-	-	12
Indian ricegrass	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	21	-	-	-	-	-
SHRUBS																					
Winterfat	-	24	8	16	31	11	-	-	-	11	-	-	9	23	27	35	39	29	-	-	-
Fourwing saltbush	88	96	203	85	171	135	12	-	100	-	-	71	-	-	80	39	-	216	-	19	-
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FORBS																					
Scarlet globemallow	-	-	-	8	-	-	-	-	-	6	-	-	-	-	-	-	-	-	8	-	5
Penstemon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OTHER SPECIES																					
Russian thistle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO VEGETATIVE COVER	182	58	21	69	34	31	23	116	22	114	40	21	133	74	39	161	48	44	98	33	184
LITTER	135	-	22	94	144	26	149	32	45	56	109	63	153	75	76	130	51	45	46	17	30
STANDING LITTER	22	63	15	101	135	43	104	147	151	114	158	112	38	140	105	26	158	30	94	212	34

* Values are total cm of above ground vegetative cover by species. Transect lines averaged 350 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 3. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE USBM SHALE TREATMENTS, NORTH-ASPECT, LOW-ELEVATION STUDY SITE, 1977.

	60 cm Soil Cover/USBM						15 cm Soil Cover/USBM						USBM Spent Shale						Soil Control		
	13			11			9			7			5			3			1		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
PERENNIAL GRASSES																					
Western wheatgrass	73*	77	101	67	18	50	42	136	54	49	83	78	71	88	62	71	81	38	134	34	95
Bluebunch wheatgrass	18	34	48	-	22	67	37	48	90	20	82	69	173	105	115	71	106	76	37	14	31
Indian ricegrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SHRUBS																					
Winterfat	11	14	-	21	44	49	8	-	21	15	21	71	-	16	-	56	-	23	-	18	8
Fourwing saltbush	45	-	4	56	-	-	-	-	105	95	-	-	-	-	102	-	-	10	-	65	-
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FORBS																					
Scarlet globemallow	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Penstemon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OTHER SPECIES																					
Russian thistle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO VEGETATIVE COVER	12	22	11	-	8	-	8	-	-	19	-	-	24	11	-	75	6	25	11	34	22
LITTER	103	51	17	69	154	69	74	157	84	43	87	68	108	78	64	56	127	123	72	49	-
STANDING LITTER	88	142	46	134	86	145	165	44	35	126	100	92	17	43	30	36	20	45	59	124	184

* Values are total cm of above ground vegetative cover by species. Transect lines averaged 350 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 4. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE USBM SHALE TREATMENTS, SOUTH-ASPECT, LOW-ELEVATION STUDY SITE, 1977.

	60 cm Soil Cover/USBM						15 cm Soil Cover/USBM						USBM Spent Shale						Soil Control		
	14			12			10			8			6			4			2		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
PERENNIAL GRASSES																					
Western wheatgrass	23*	15	135	25	29	29	25	21	31	6	37	11	22	23	45	18	30	14	15	36	23
Bluebunch wheatgrass	31	-	-	46	10	30	-	-	-	-	-	-	7	5	40	19	12	18	3	22	9
Indian ricegrass	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-
SHRUBS																					
Winterfat	26	-	5	19	56	8	20	16	-	37	22	20	17	71	26	11	50	21	17	25	40
Fourwing saltbush	106	133	179	-	-	95	14	58	21	24	96	84	148	32	67	31	-	183	-	-	50
Rabbitbrush	-	-	-	12	-	-	-	7	-	-	-	11	-	-	-	-	-	-	-	-	-
FORBS																					
Scarlet globemallow	-	-	-	-	-	-	-	-	-	6	-	-	7	-	-	-	-	-	-	-	-
Penstemon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OTHER SPECIES																					
Russian thistle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO VEGETATIVE COVER	132	65	28	110	105	31	111	76	51	100	74	68	126	75	26	77	64	62	24	109	37
LITTER	22	74	27	46	15	67	-	89	92	48	29	94	15	78	28	167	80	30	96	144	75
STANDING LITTER	-	53	192	49	114	80	182	74	137	130	82	64	-	48	112	91	106	13	188	68	29

* Values are total cm of above ground vegetative cover by species. Transect lines averaged 350 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 5. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE TOSCO SHALE TREATMENTS, NORTH-ASPECT, LOW-ELEVATION STUDY SITE, 1977.

Depth (cm)	30 cm Soil Cover/TOSCO								15 cm Soil Cover/TOSCO							
	I				III				V				VII			
	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16
15	5.7*	2.5	5.0	8.7	7.3	1.8	7.5	13.5	12.2	5.8	3.3	10.0	10.5	1.7	2.5	11.0
30	17.0	10.0	12.5	10.3	17.0	11.5	11.5	12.3	17.0	8.3	9.2	12.2	17.8	10.8	7.5	15.7
45	15.3	12.3	14.7	10.3	16.3	14.8	11.5	9.7	20.3	17.3	14.0	12.5	19.5	16.5	13.2	15.0
60	12.2	8.3	15.7	9.3	15.3	15.7	14.8	10.3	21.0	18.2	14.8	12.2	21.0	19.0	15.8	13.0
75	13.8	12.3	15.7	8.7	15.3	17.3	15.7	10.3	21.8	19.8	18.2	13.8	21.8	21.5	16.5	14.3
90	14.5	14.8	14.0	8.0	15.3	15.7	16.5	11.0	21.8	20.5	19.8	14.3	22.7	20.3	19.8	15.7
105	14.5	14.8	14.0	8.7	17.0	16.5	16.5	11.5	24.3	23.0	21.5	15.0	22.7	21.5	22.3	17.0
120	15.3	14.8	15.7	9.3	18.7	18.2	17.3	12.8	24.3	23.8	23.0	16.8	23.5	22.3	24.0	18.3
135	14.5	14.0	18.2	10.8	18.7	19.0	17.3	13.5	25.2	25.5	21.5	16.3	23.5	26.3	24.7	18.3
150	16.3	15.7	18.2	10.8	19.5	19.8	17.3	14.3	--	--	--	--	--	--	--	--
165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	TOSCO Spent Shale								Soil Control			
	IX				XI				XIII			
	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/14
15	12.2	4.2	8.3	12.5	12.2	5.8	5.8	10.7	11.3	5.3	4.3	11.5
30	22.2	17.3	19.8	13.2	22.7	16.5	14.0	12.2	16.2	9.0	13.2	15.3
45	23.5	21.5	21.5	13.7	22.8	22.2	19.8	12.5	17.0	12.3	16.5	15.3
60	23.5	23.8	23.0	14.3	24.3	22.2	21.5	13.2	17.0	14.0	16.5	13.3
75	23.5	23.7	22.3	14.3	24.3	23.8	22.3	15.0	17.0	14.8	18.2	12.8
90	24.3	24.7	24.7	15.3	24.3	23.0	22.3	15.7	17.0	15.7	16.5	12.8
105	23.5	23.0	25.5	16.0	24.3	23.8	23.0	16.7	17.8	16.5	15.7	13.3
120	26.0	24.7	24.7	16.0	26.0	23.8	25.5	16.0	17.0	15.7	18.2	14.0
135	--	--	--	--	25.2	23.0	24.7	18.3	17.0	15.7	22.3	14.5
150	--	--	--	--	--	--	--	--	--	--	--	--
165	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

EPA Form 2350-4 (4-8
(PREVIOUSLY CIN FORM 287)
TYPING GUIDE SHEET

APPENDIX TABLE 6. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE TOSCO SHALE TREATMENTS, SOUTH-ASPECT, LOW-ELEVATION STUDY SITE, 1977.

Depth (cm)	30 cm Soil Cover/TOSCO								15 cm Soil Cover/TOSCO							
	II				IV				VI				VIII			
	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16
15	8.8*	3.3	3.8	11.2	10.5	5.0	11.7	14.5	8.0	2.5	6.5	14.7	8.0	2.5	3.8	16.2
30	13.8	12.0	10.8	16.3	12.2	10.8	12.5	20.0	13.8	10.8	11.7	19.0	13.8	6.7	10.8	18.3
45	15.3	14.8	14.3	14.5	12.2	10.7	17.7	19.3	15.3	14.0	16.8	13.3	16.2	12.3	16.8	18.3
60	15.3	14.8	16.0	12.8	12.2	12.3	17.7	14.5	16.3	15.7	20.3	17.5	17.0	17.3	20.3	17.5
75	16.3	14.0	16.0	12.0	14.5	14.0	18.7	13.8	18.7	18.2	21.2	17.0	18.7	18.2	21.2	16.8
90	16.3	13.2	15.0	13.8	14.5	14.8	17.7	13.0	19.5	20.5	23.0	17.5	20.3	19.0	24.7	18.3
105	16.3	14.0	16.0	13.8	16.3	14.8	25.5	14.5	21.8	21.5	24.8	19.0	21.8	21.5	23.8	18.3
120	15.3	14.8	16.0	13.8	16.3	15.7	21.2	14.5	21.8	21.5	27.3	20.5	23.5	23.7	25.5	19.7
135	17.8	16.5	16.0	14.5	17.0	15.7	21.2	14.5	21.8	22.2	26.5	19.5	25.2	23.0	26.5	25.5
150	17.8	16.5	17.7	15.3	17.0	16.5	22.0	14.5	21.8	21.5	28.3	21.5	--	--	--	--
165	18.7	17.3	17.7	15.8	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	TOSCO Spent Shale								Soil Control			
	X				XII				XIV			
	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16
15	9.8	6.7	5.5	14.2	10.5	4.2	5.5	15.3	8.0	3.3	6.5	15.7
30	18.7	17.3	14.3	17.2	18.7	14.0	19.5	19.3	15.3	12.3	12.5	15.7
45	21.0	20.5	21.2	20.2	18.7	18.2	23.0	20.0	15.3	14.0	17.7	14.2
60	23.5	21.5	23.8	23.3	21.0	19.8	23.8	20.8	15.3	15.7	18.7	14.2
75	23.5	23.0	24.7	20.2	21.0	20.5	25.5	20.8	15.3	15.7	19.5	14.8
90	23.5	23.8	25.5	21.7	21.8	20.5	24.7	21.7	15.3	15.7	18.7	14.8
105	24.3	23.8	26.5	21.8	21.7	22.2	26.5	23.2	15.3	14.8	20.5	14.8
120	24.3	23.8	28.2	22.2	23.5	22.2	27.3	24.0	16.2	17.3	18.7	15.7
135	25.2	23.8	28.2	22.2	--	--	--	--	17.8	18.2	18.7	15.7
150	--	--	--	--	--	--	--	--	17.8	18.2	19.5	15.7
165	--	--	--	--	--	--	--	--	21.8	21.5	20.3	16.2

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

APPENDIX TABLE 7. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE USBM SHALE TREATMENTS, NORTH-ASPECT, LOW-ELEVATION STUDY SITE, 1977.

Depth (cm)	60 cm Soil Cover/USBM								15 cm Soil Cover/USBM							
	13				11				9				7			
	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16
15	13.8	2.8	3.0	16.8	7.3	5.3	3.8	10.7	7.3	2.8	2.0	10.3	8.0	1.8	2.0	12.7
30	16.8	11.2	10.8	21.5	12.2	12.0	11.7	11.3	19.5	10.3	12.5	19.2	19.5	11.2	14.3	21.5
45	15.3	12.8	13.3	17.5	12.2	12.0	13.3	10.0	18.7	14.5	14.3	12.7	19.5	13.8	16.8	19.2
60	14.5	12.8	14.3	14.3	13.0	12.0	13.3	10.7	15.3	15.3	14.3	12.0	17.8	15.3	17.7	17.5
75	16.2	15.3	16.8	12.7	15.3	16.3	17.7	12.0	13.8	13.7	12.5	11.2	16.2	16.3	19.5	18.3
90	16.2	16.3	21.3	19.3	16.2	17.0	19.5	14.7	15.3	15.3	11.7	11.2	17.0	17.0	19.5	19.2
105	17.0	17.0	23.0	20.0	17.8	18.0	19.5	14.0	18.7	18.0	15.0	12.0	18.7	18.8	21.2	20.0
120	18.7	18.0	23.8	20.8	17.8	18.8	17.7	13.3	19.5	20.5	17.7	14.3	19.5	20.5	23.0	21.5
135	20.3	19.5	24.7	20.8	17.8	18.8	19.5	13.3	20.3	20.5	19.5	16.8	21.0	21.3	23.7	21.5
150	18.7	19.5	24.7	20.8	20.3	20.5	23.0	16.8	22.7	23.0	21.2	17.3	21.0	22.2	23.8	21.5
165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	USBM Spent Shale								Soil Control			
	5				3				1			
	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16
15	11.3	6.2	5.5	11.3	10.5	3.5	4.7	13.8	10.5*	3.5	3.8	13.8
30	17.0	12.8	11.7	11.3	17.8	9.5	14.3	16.5	18.7	12.0	13.3	19.4
45	14.5	13.8	14.3	11.3	15.3	13.7	18.5	15.2	14.5	13.7	14.3	13.8
60	14.5	14.5	14.3	11.3	14.5	14.5	19.5	15.2	13.8	13.7	16.0	12.0
75	15.3	17.0	16.0	13.3	16.2	16.3	22.0	16.5	18.7	12.8	15.0	12.0
90	17.0	18.8	17.8	13.3	17.0	17.0	23.8	16.5	13.8	14.5	15.0	12.5
105	17.0	17.0	16.8	13.3	18.7	18.0	23.0	17.3	13.8	13.8	16.0	12.5
120	17.8	18.0	18.5	15.3	18.7	19.5	24.7	18.7	13.8	13.8	16.8	12.5
135	18.7	19.5	21.2	16.0	18.7	18.8	24.7	18.7	16.2	15.3	16.0	15.2
150	--	--	--	--	--	--	--	--	17.0	18.0	17.7	15.2
165	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

APPENDIX TABLE 8. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE USBM SHALE TREATMENTS, SOUTH-ASPECT, LOW-ELEVATION STUDY SITE, 1977.

Depth (cm)	60 cm Soil Cover/USBM								15 cm Soil Cover/USBM							
	14				12				10				8			
	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16
15	7.3	2.8	1.5	11.7	8.0	4.3	5.5	10.8	4.0	1.8	4.8	12.3	4.0	2.8	8.0	13.3
30	10.5	9.5	10.3	18.7	11.3	10.3	11.2	11.5	12.3	12.8	11.2	16.7	12.3	12.0	12.7	22.0
45	12.2	11.8	12.0	15.0	12.2	11.2	12.7	11.5	13.0	12.0	13.5	12.3	13.8	15.3	14.3	16.8
60	12.2	12.8	13.5	13.3	12.2	13.7	15.2	12.5	12.2	12.0	14.3	9.7	14.5	16.3	15.2	16.0
75	13.8	14.5	16.8	15.0	13.8	12.8	17.5	15.7	11.3	11.2	15.2	9.7	14.5	18.0	14.3	16.0
90	19.5	18.0	16.0	16.0	17.0	13.8	17.5	17.3	11.3	10.3	15.2	11.0	16.2	18.0	16.0	16.0
105	19.5	22.2	16.0	16.0	17.0	18.0	17.5	16.5	11.3	12.8	17.5	11.5	18.7	20.5	18.3	16.0
120	21.0	22.3	17.5	16.8	17.8	18.8	20.0	19.0	14.5	15.3	20.8	13.5	20.3	20.5	19.3	18.7
135	20.3	22.3	19.2	17.7	18.7	17.0	19.2	18.2	16.2	17.0	20.8	14.2	21.0	21.3	20.0	21.2
150	21.8	23.0	17.5	17.7	18.7	18.0	20.8	18.8	17.8	18.8	21.5	14.5	23.0	22.2	22.3	23.0
165	24.3	22.3	18.0	18.0	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	USBM Spent Shale								Soil Control			
	6				4				2			
	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16	4/14	5/16	7/6	9/16
15	8.8	3.5	4.8	17.5	8.8	5.3	3.0	13.3	8.8	5.3	4.0	16.7
30	13.3	12.0	11.2	21.5	19.5	14.5	9.5	19.0	7.3	11.2	9.5	22.0
45	12.3	13.8	12.7	16.8	18.7	16.3	11.2	14.0	11.3	12.8	12.7	16.7
60	13.0	12.8	14.2	14.3	17.0	18.8	14.3	12.5	13.8	12.0	13.5	13.0
75	14.5	15.3	16.8	16.8	17.8	20.5	15.0	15.7	13.0	14.5	12.7	13.0
90	12.3	15.3	17.5	16.8	19.5	21.3	17.5	16.5	13.8	13.7	14.3	15.7
105	16.2	15.3	16.8	16.8	21.0	20.5	19.2	16.5	14.5	14.5	13.5	13.0
120	18.7	17.0	19.2	16.8	21.0	22.2	19.2	17.3	14.5	15.3	12.8	16.7
135	20.5	18.0	20.0	18.3	22.7	23.0	20.0	17.3	14.5	16.3	14.3	16.7
150	--	--	--	--	23.5	23.8	20.0	17.5	15.3	18.0	17.5	19.3
165	--	--	--	--	--	--	--	--	15.3	17.0	18.0	19.8

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

APPENDIX TABLE 9. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE TOSCO SHALE TREATMENTS, NORTH-ASPECT, LOW-ELEVATION STUDY SITE, 1978.

	30 cm Soil Cover/TOSCO						15 cm Soil Cover/TOSCO						TOSCO Spent Shale						Soil Control		
	I			III			V			VII			IX			XI			XIII		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
PERENNIAL GRASSES																					
Western wheatgrass	44*	66	215	106	127	216	111	174	238	41	218	208	5	140	205	34	113	152	100	226	119
Bluebunch wheatgrass	-	41	63	-	-	37	10	-	35	-	-	50	-	-	-	-	14	24	15	12	74
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian ricegrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	10	-	-	-
SHRUBS																					
Fourwing saltbush	7	-	-	69	27	10	-	-	-	-	140	-	-	-	-	165	24	135	-	150	-
Winterfat	2	-	-	27	42	-	10	13	-	75	32	-	77	70	-	20	-	-	20	-2	-
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FORBS																					
Scarlet globemallow	2	-	-	-	-	-	5	-	-	5	-	-	-	-	-	-	-	-	-	-	16
Penstemon	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mint	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OTHER SPECIES																					
Cheatgrass	9	8	11	-	24	16	61	76	45	146	70	77	2	10	16	36	183	53	-	77	10
Russian thistle	-	-	3	-	-	-	-	-	-	5	5	-	6	-	10	-	-	2	-	11	-
Kochia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mustard	-	-	-	-	15	-	57	5	-	111	192	15	119	-	266	116	180	175	25	-	15
Dandelion	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polygonum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21
Storksbill	8	-	-	-	10	2	5	5	3	-	-	9	11	-	-	-	9	-	-	-	-
Aegilops	-	6	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	105	-	-
NO VEGETATIVE COVER	242	110	-	122	65	18	36	-	2	54	25	-	140	30	20	64	39	40	143	-	46
LITTER	30	104	82	23	25	42	35	77	22	24	0	-	-	100	33	-	-	-	6	8	46

* Values are total cm of above ground vegetative cover by species. Transect lines averaged 350 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 10. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE TOSCO SHALE TREATMENTS, SOUTH-ASPECT, LOW-ELEVATION STUDY SITE, 1978.

	30 cm Soil Cover/TOSCO						15 cm Soil Cover/TOSCO						TOSCO Spent Shale						Soil Control		
	II			IV			VI			VIII			X			XII			XIV		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
PERENNIAL GRASSES																					
Western wheatgrass	27*	4	18	75	90	120	82	53	208	94	87	110	-	31	25	6	17	37	97	92	125
Bluebunch wheatgrass	-	-	42	-	-	-	-	-	-	-	-	-	-	-	-	-	15	-	-	-	56
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian ricegrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SHRUBS																					
Fourwing saltbush	105	160	350	80	120	310	-	8	140	45	-	80	-	80	-	75	-	-	-	-	-
Winterfat	17	35	15	23	20	20	14	-	2	2	27	-	17	30	75	45	33	35	-	-	-
Rabbitbrush	15	10	-	-	-	-	-	20	-	20	10	-	-	-	-	-	-	-	-	-	-
FORBS																					
Scarlet globemallow	-	2	-	-	4	-	-	-	5	3	12	-	-	-	-	-	-	-	-	-	22
Penstemon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mint	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OTHER SPECIES																					
Cheatgrass	2	-	27	5	-	-	7	5	6	13	-	46	-	8	-	-	5	-	-	-	-
Russian thistle	-	-	-	-	2	-	3	-	-	-	2	5	2	-	-	2	-	-	-	-	-
Kochia	11	-	-	11	10	-	6	23	5	-	7	2	2	-	5	-	4	-	-	-	-
Mustard	96	20	26	85	22	20	146	147	21	26	67	18	145	140	92	110	171	33	122	195	21
Dandelion	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polygonum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Storksbill	10	-	-	12	-	-	6	-	5	5	15	7	9	9	5	-	-	-	-	10	-
Aegilops	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO VEGETATIVE COVER	88	127	-	71	102	30	89	84	28	120	72	128	165	136	149	133	135	75	127	50	131
LITTER	-	-	20	-	-	-	23	9	85	22	79	-	10	19	-	-	-	170	-	-	-

* Values are total cm of above ground vegetative cover by species. Transect lines averaged 350 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 11. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE USBM SHALE TREATMENTS, NORTH-ASPECT, LOW-ELEVATION STUDY SITE, 1978.

	60 cm Soil Cover/USBM						15 cm Soil Cover/USBM						USBM Spent Shale						Soil Control		
	13			11			9			7			5			3			1		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
PERENNIAL GRASSES																					
Western wheatgrass	139*	222	96	121	102	212	169	204	149	209	190	266	62	98	137	12	103	61	244	165	247
Bluebunch wheatgrass	5	-	50	-	-	-	-	-	20	60	-	12	21	46	126	58	-	35	-	-	-
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian ricegrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SHRUBS																					
Fourwing saltbush	159	30	246	-	12	-	-	-	147	-	-	-	-	-	140	-	-	-	-	100	48
Winterfat	-	30	-	22	51	50	65	7	-	51	47	26	-	-	-	113	-	50	11	-	27
Rabbitbrush	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
FORBS																					
Scarlet globemallow	-	-	-	-	11	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-
Penstemon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mint	-	-	-	-	40	14	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-
OTHER SPECIES																					
Cheatgrass	-	48	42	10	-	32	-	-	7	-	15	-	115	28	28	-	128	102	-	-	45
Russian thistle	-	-	-	4	-	-	-	-	-	7	-	-	-	3	-	-	-	4	-	-	-
Kochia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-
Mustard	6	-	-	45	-	4	-	-	-	58	-	-	97	-	-	-	-	69	-	-	-
Dandelion	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polygonum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Storksbill	-	-	-	28	-	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
Aegilops	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31	-	-	-	-	27	-
NO VEGETATIVE COVER	26	-	-	31	41	26	38	-	-	18	-	-	-	-	-	57	-	-	15	-	-
LITTER	51	48	27	95	100	73	125	182	18	37	85	50	87	150	37	45	61	15	16	20	-

* Values are total cm of above ground vegetative cover by species. Transect lines averaged 350 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 12. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE USBM SHALE TREATMENTS, SOUTH-ASPECT, LOW-ELEVATION STUDY SITE, 1978.

	60 cm Soil Cover/USBM						15 cm Soil Cover/USBM						USBM Spent Shale						Soil Control		
	14			12			10			8			6			4			2		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
PERENNIAL GRASSES																					
Western wheatgrass	125*	83	114	139	186	93	76	35	74	61	27	30	5	61	60	13	70	20	139	170	130
Bluebunch wheatgrass	-	-	10	-	-	-	-	-	-	-	-	-	-	63	-	-	11	-	21	-	-
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian ricegrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SHRUBS																					
Fourwing saltbush	-	150	217	-	35	120	-	96	85	29	120	240	105	176	100	-	-	205	24	-	280
Winterfat	55	5	6	-	19	16	55	36	15	62	52	10	92	-	61	105	102	33	-	43	42
Rabbitbrush	15	-	14	-	-	-	-	6	2	10	-	-	3	-	-	-	-	-	-	-	-
FORBS																					
Scarlet globemallow	-	4	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-
Penstemon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mint	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OTHER SPECIES																					
Cheatgrass	-	50	29	-	-	15	-	14	49	-	-	16	27	-	52	-	12	-	5	-	10
Russian thistle	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kochia	-	3	-	-	-	-	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-
Mustard	-	90	-	17	-	-	-	40	46	-	-	-	10	10	-	-	3	-	-	69	-
Dandelion	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polygonum	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-
Dock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Storksbill	22	-	-	14	24	22	-	23	-	7	70	-	-	-	-	-	-	-	-	17	0
Aegilops	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
NO VEGETATIVE COVER	114	22	-	107	121	49	106	70	5	79	49	24	84	50	50	217	70	100	144	70	30
LITTER	11	64	-	-	77	-	19	61	72	62	5	30	98	55	86	56	14	20	52	61	-

* Values are in total cm of above ground vegetative cover by species. Transect lines averaged 350 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 13. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE TOSCO SHALE TREATMENTS, NORTH-ASPECT, LOW-ELEVATION STUDY SITE, 1978.

Depth (cm)	30 cm Soil Cover/TOSCO												15 cm Soil Cover/TOSCO											
	I						III						V						VII					
	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13
15	14.0*	8.7	5.1	4.7	3.8	5.1	19.5	9.1	6.3	5.5	4.9	5.5	20.0	16.5	7.8	5.0	4.7	5.5	22.0	16.0	5.0	4.2	3.4	4.2
30	20.5	14.2	9.9	8.5	7.6	8.0	23.0	17.4	10.3	8.2	7.9	6.9	32.0	24.0	12.6	7.8	7.1	6.4	28.0	22.0	11.8	8.0	8.2	8.0
45	26.5	20.1	10.9	8.5	7.6	7.5	26.5	22.3	11.8	7.8	7.4	6.9	32.0	24.0	17.8	8.8	11.6	11.8	29.0	23.2	16.5	12.5	13.9	13.5
60	26.5	22.7	12.0	9.0	8.6	8.5	28.0	22.3	13.2	8.7	9.0	8.3	32.0	25.3	19.5	16.5	15.3	15.4	29.0	24.4	19.2	17.8	17.8	16.7
75	26.5	20.1	14.0	10.9	10.0	10.5	26.5	21.0	15.4	10.1	10.6	9.8	30.5	26.6	21.2	18.1	17.5	17.0	29.0	25.8	20.9	19.5	18.3	18.4
90	25.5	21.4	15.1	12.5	11.6	10.5	25.5	21.0	16.5	12.6	13.2	11.3	32.0	28.0	21.8	19.8	19.2	18.1	28.0	25.8	22.7	21.2	20.1	18.4
105	24.0	21.4	16.2	14.0	12.7	12.5	25.5	22.3	18.1	14.7	14.3	13.3	32.0	29.4	23.5	20.9	21.0	19.8	25.5	25.8	23.2	21.2	20.7	19.5
120	22.0	20.1	16.7	14.6	13.7	13.0	25.5	22.3	19.8	16.3	16.0	13.8	32.0	28.0	24.1	21.5	21.0	20.4	--	25.8	23.2	21.2	21.2	19.0
135	19.5	20.1	17.3	15.1	14.8	13.0	22.0	23.6	20.3	16.8	17.1	14.9	32.0	28.0	24.1	22.1	22.1	20.4	--	--	--	--	--	20.6
150	16.5	20.1	19.0	16.2	15.9	14.0	21.0	23.6	21.5	17.8	17.7	15.4	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	TOSCO Spent Shale												Soil Control					
	IX						XI						XIII					
	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/12	8/2	9/13
15	22.0	14.2	5.0	3.8	2.4	3.8	28.0	17.6	5.6	3.7	3.4	3.8	18.5	9.5	6.3	5.6	4.7	5.1
30	30.5	22.7	13.3	8.5	9.2	9.0	32.0	25.3	15.1	10.3	10.2	9.9	20.5	13.8	9.7	9.5	9.1	9.0
45	32.0	26.6	18.6	15.6	15.0	14.0	32.0	28.0	20.6	16.5	16.1	14.6	23.5	17.1	11.6	11.5	11.1	10.9
60	32.0	26.6	21.5	17.8	17.8	16.7	32.0	26.6	21.2	18.1	17.8	16.7	25.0	19.5	13.2	13.0	11.6	12.5
75	32.0	28.0	23.2	19.5	18.3	17.8	32.0	26.6	22.5	19.8	18.9	17.3	25.5	20.7	13.7	12.5	12.8	12.5
90	32.0	28.0	22.1	21.2	20.7	18.4	32.0	26.6	23.6	20.4	20.1	18.4	26.5	23.2	17.3	15.1	13.2	13.0
105	30.5	28.0	23.2	21.8	20.1	19.0	32.0	28.0	24.2	21.5	20.1	19.0	25.0	23.2	18.4	15.1	14.3	13.0
120	--	28.0	--	--	--	19.5	32.0	28.0	23.0	20.4	21.2	19.5	22.0	23.2	20.0	16.2	14.3	12.5
135	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
150	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

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APPENDIX TABLE 14. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE TOSCO SHALE TREATMENTS, SOUTH-ASPECT, LOW-ELEVATION STUDY SITE, 1978.

Depth (cm)	30 cm Soil Cover/TOSCO												15 cm Soil Cover/TOSCO											
	II						IV						VI						VIII					
	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13
15	16.5*	8.7	6.0	6.3	4.3	4.7	19.5	9.5	7.5	7.0	5.7	6.1	16.5	11.6	5.6	4.6	4.8	4.2	19.5	12.7	5.6	4.2	3.3	4.2
30	20.5	13.0	10.5	8.7	8.8	7.1	21.0	13.7	10.5	9.0	8.1	8.1	32.0	19.5	9.9	7.4	7.8	7.0	26.5	20.7	7.5	5.6	5.2	6.0
45	28.0	18.9	13.0	9.2	8.8	8.1	25.5	17.1	9.9	8.0	7.1	7.1	32.0	21.0	14.6	11.3	10.9	10.5	25.5	23.2	13.0	9.5	9.1	9.5
60	26.5	20.1	14.0	10.1	9.3	8.1	25.5	18.3	12.5	8.5	8.1	7.6	32.0	23.2	17.3	15.4	14.7	14.0	25.5	23.2	16.2	13.5	13.2	13.0
75	25.5	20.1	15.1	10.1	9.3	8.6	24.0	18.3	13.0	9.9	9.6	9.1	32.0	23.2	20.1	17.0	16.9	16.2	25.5	24.4	19.0	16.7	14.8	14.0
90	20.0	20.1	15.6	12.1	10.9	9.1	23.0	18.3	15.6	11.5	11.6	11.1	29.0	24.4	21.2	19.2	18.6	17.3	25.5	25.8	20.1	19.5	17.5	15.6
105	19.0	20.1	16.2	13.7	12.5	10.6	22.5	19.5	16.2	13.5	12.7	12.7	29.0	25.8	21.8	20.4	19.2	17.3	26.5	25.8	23.0	20.6	19.8	17.3
120	19.0	21.4	17.3	15.2	15.2	12.1	23.0	19.5	16.2	15.6	15.3	13.2	28.0	25.8	22.4	21.5	20.4	17.3	26.5	27.1	24.2	21.2	20.4	18.4
135	16.5	20.1	18.4	16.8	16.9	14.3	20.5	20.7	19.0	17.8	15.9	14.8	28.0	25.8	21.2	20.4	19.8	17.3	--	--	--	--	--	--
150	12.0	20.1	19.5	17.3	16.9	15.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	TOSCO Spent Shale												Soil Control					
	X						XII						XIV					
	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13
15	23.0	13.0	6.2	5.0	4.9	5.1	25.5	16.9	4.6	4.3	3.8	4.2	18.5	8.2	6.9	6.0	5.3	6.0
30	26.5	22.7	16.1	13.8	14.9	14.0	25.5	20.7	12.8	9.6	9.7	9.5	22.5	13.4	11.3	11.5	11.3	10.9
45	26.5	22.7	18.3	16.0	18.3	17.3	25.5	23.2	17.0	14.8	14.5	14.0	22.0	15.5	13.3	12.5	12.8	12.5
60	26.5	24.0	21.9	19.2	19.5	18.4	25.5	23.2	19.2	16.4	16.6	15.6	21.0	14.5	12.8	12.5	12.3	12.5
75	28.0	26.6	22.5	19.8	21.3	18.4	25.5	23.2	20.3	18.6	17.8	16.2	23.0	15.5	13.8	13.5	12.8	13.0
90	26.5	25.3	23.8	20.4	20.7	19.5	26.5	25.8	22.7	19.8	18.3	17.3	28.0	17.8	14.4	13.0	12.8	13.0
105	25.5	26.6	23.1	21.5	21.3	19.0	25.5	25.8	22.7	20.4	20.7	19.5	25.5	18.9	16.0	14.0	14.5	14.0
120	25.5	25.3	23.7	20.4	20.7	19.5	--	25.7	--	--	--	19.5	25.5	21.2	19.8	17.8	17.8	16.2
135	--	--	--	--	--	--	--	--	--	--	--	--	22.5	20.1	20.4	18.4	17.8	16.2
150	--	--	--	--	--	--	--	--	--	--	--	--	19.5	20.1	20.9	19.5	18.9	16.7

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

APPENDIX TABLE 15. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE USBM SHALE TREATMENTS, NORTH-ASPECT, LOW-ELEVATION STUDY SITE, 1978.

Depth (cm)	60 cm Soil Cover/USBM												15 cm Soil Cover/USBM											
	13						11						9						7					
	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13
15	13.5*	9.2	5.7	5.2	4.7	4.8	18.0	9.7	6.7	5.7	5.2	4.7	14.0	10.8	7.1	5.6	4.4	5.8	14.0	8.4	6.2	4.2	4.3	4.3
30	23.0	12.7	9.6	8.6	8.1	8.2	22.0	14.2	9.7	9.6	9.6	9.1	23.5	21.4	12.7	9.9	9.8	10.2	32.0	20.7	12.8	11.5	10.0	10.2
45	22.5	14.9	10.0	9.6	9.1	9.2	21.0	16.5	11.8	10.6	10.0	9.6	25.5	22.7	16.4	12.5	12.5	11.8	30.5	22.0	16.6	13.5	12.1	11.8
60	25.0	20.7	13.2	10.0	11.1	10.7	25.0	21.4	15.5	11.6	11.1	11.6	32.0	22.7	18.0	12.5	12.5	11.8	28.0	23.2	18.3	15.1	14.3	12.3
75	25.5	23.2	15.3	11.6	12.7	10.7	28.0	25.3	18.9	14.3	13.2	13.2	28.0	22.7	18.0	14.0	13.0	12.3	26.5	23.2	18.9	16.2	14.8	13.4
90	25.0	22.0	17.0	12.7	11.1	11.8	25.5	25.3	19.5	15.9	14.3	13.2	28.0	22.7	18.6	16.2	15.2	13.4	26.5	23.2	20.1	17.3	16.4	14.5
105	25.0	22.0	18.0	13.2	12.7	11.8	23.5	24.0	19.5	17.0	14.8	13.2	28.0	25.3	19.8	16.7	16.3	14.5	25.5	23.2	20.7	16.7	17.0	16.1
120	24.0	22.0	18.6	16.4	14.3	13.4	25.5	24.0	20.7	18.0	17.0	14.3	28.0	24.0	21.0	17.3	16.9	14.5	25.5	23.2	21.2	19.0	17.5	16.6
135	23.0	22.0	18.6	17.0	15.3	13.4	25.0	24.0	21.9	18.0	17.5	15.3	26.5	24.0	21.5	18.4	16.9	16.1	28.0	24.4	21.9	19.0	18.6	17.2
150	23.5	23.2	19.8	17.5	15.3	14.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	17.8

Depth (cm)	USBM Spent Shale												Soil Control					
	5						3						1					
	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13
15	12.0	14.0	6.7	5.1	5.3	5.1	22.0	14.9	7.0	5.0	4.4	5.3	16.5	8.4	5.6	5.5	4.8	6.1
30	22.5	18.6	12.3	9.9	9.7	9.0	25.5	22.0	14.6	10.8	10.9	9.7	23.0	12.8	9.9	9.8	9.3	9.6
45	25.5	21.0	16.6	13.0	12.3	10.5	25.5	23.2	19.5	13.8	13.0	11.3	24.0	12.8	10.9	10.8	10.9	10.0
60	28.0	23.6	20.1	15.1	13.4	12.0	25.5	24.4	18.4	16.0	14.8	12.3	22.0	13.8	10.9	10.3	10.4	10.0
75	28.0	26.2	22.5	17.3	16.6	14.0	26.5	23.2	20.1	17.0	16.3	13.4	23.0	18.3	11.5	10.8	12.0	11.1
90	28.0	26.2	22.5	17.8	15.0	13.5	26.5	24.4	21.2	17.5	16.9	15.0	24.0	20.7	15.1	11.8	12.5	12.1
105	26.5	26.2	21.9	16.7	14.5	13.0	25.5	24.4	21.2	18.1	17.5	15.0	24.0	22.0	15.1	11.8	12.5	12.1
120	26.5	24.8	21.9	16.7	15.5	13.0	25.5	24.4	21.2	18.1	17.5	15.5	25.0	22.0	18.4	14.4	14.1	13.7
135	29.0	26.2	23.7	18.4	17.8	15.6	25.5	23.2	21.8	17.5	17.5	15.0	25.5	22.0	19.5	17.0	16.3	15.3
150	--	--	--	--	--	--	--	--	--	--	--	--	25.5	23.2	21.8	20.4	20.4	17.0

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

APPENDIX TABLE 16. MOISTURE MEAUREMENTS (NEUTRON PROBE) FROM THE USBM SHALE TREATMENTS, SOUTH-ASPECT, LOW-ELEVATION STUDY SITE, 1978.

Depth (cm)	60 cm Soil Cover/USBM												15 Soil Cover/USBM											
	14						12						10						8					
	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13
15	16.0*	9.7	6.1	5.1	5.3	5.7	15.0	8.7	6.7	5.7	5.6	5.2	12.5	8.7	5.2	5.2	3.8	3.3	13.0	7.6	4.7	4.7	3.4	4.2
30	20.5	11.9	10.6	8.0	9.3	8.6	20.5	13.0	10.2	9.1	10.3	8.1	23.0	17.6	10.6	10.0	9.6	9.0	22.0	15.3	11.6	10.9	10.2	9.5
45	21.0	14.2	10.6	9.5	9.8	9.6	20.5	14.2	11.3	9.6	10.9	9.1	25.5	20.1	12.1	11.1	11.6	9.9	23.0	17.6	13.7	13.0	12.8	12.0
60	22.0	15.3	11.1	9.9	10.4	10.0	23.5	18.9	12.3	10.6	12.7	10.0	24.0	20.1	14.3	11.1	10.6	9.5	23.5	20.1	15.7	14.0	13.9	12.5
75	23.5	21.4	16.4	13.5	14.1	12.1	25.0	21.4	15.0	12.1	14.6	11.1	22.5	20.1	14.3	12.1	11.6	9.5	25.5	22.7	17.5	16.7	16.1	14.0
90	32.0	25.3	19.2	17.3	16.9	14.3	25.5	21.4	17.8	14.3	15.9	12.7	20.5	17.6	15.3	13.2	11.1	9.9	25.5	22.7	19.2	16.7	15.5	14.6
105	30.5	25.3	19.8	19.0	18.0	16.4	24.0	22.6	18.3	16.4	16.5	13.2	22.5	21.4	16.4	15.3	13.2	11.5	24.0	22.7	20.3	16.7	15.5	14.0
120	29.0	25.3	21.0	19.5	18.0	16.4	24.0	21.4	18.3	15.9	16.5	12.7	25.0	24.0	18.6	17.0	15.3	12.5	25.5	24.0	20.3	17.3	16.6	14.6
135	28.0	26.6	21.5	19.5	18.0	15.9	23.5	22.6	18.9	15.9	17.2	13.2	23.0	24.0	20.3	17.5	16.4	13.5	24.0	25.3	21.0	17.3	17.8	15.1
150	28.0	26.6	21.5	18.4	17.5	15.9	25.5	25.3	20.7	16.4	19.2	14.3	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	USBM Spent Shale												Soil Control					
	6						4						2					
	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13	4/4	5/16	6/12	7/17	8/2	9/13
15	20.0	13.0	7.2	5.6	5.3	5.3	18.5	14.7	6.6	6.0	4.8	4.8	15.5	8.7	6.7	5.8	4.4	5.8
30	23.5	20.1	12.3	9.5	9.7	9.2	32.0	22.1	15.3	12.0	10.2	9.2	21.0	13.0	10.2	9.7	9.8	9.2
45	25.0	21.3	13.4	10.9	10.2	10.2	32.0	23.4	17.0	13.5	13.4	12.3	22.0	15.3	12.3	10.2	10.4	10.2
60	23.5	21.3	14.5	11.5	11.7	11.3	32.0	24.7	19.2	16.2	15.0	13.9	22.5	15.3	12.3	11.3	10.9	10.2
75	23.0	21.3	16.6	13.0	12.8	12.3	32.0	24.7	19.2	17.3	16.6	15.0	22.5	18.9	12.8	11.3	10.8	10.7
90	21.0	21.3	16.6	14.6	13.4	12.8	32.0	24.7	19.8	17.8	16.6	15.5	23.0	18.9	13.9	11.8	11.4	10.7
105	23.0	21.3	18.3	16.2	14.5	14.5	30.5	24.7	20.3	18.4	17.8	16.6	23.0	21.4	16.6	12.8	12.0	12.3
120	23.5	22.7	18.9	16.7	16.1	14.5	32.0	24.7	21.5	19.0	18.9	17.8	24.0	22.7	19.5	15.5	13.6	13.4
135	23.5	25.3	21.9	19.0	17.8	16.1	32.0	26.1	22.1	20.1	18.3	17.2	25.0	25.3	21.2	18.3	18.0	16.6
150	--	--	--	--	--	--	--	--	--	--	--	--	22.0	21.4	21.2	18.3	18.0	16.6

* Values are in percent moisture by volume as determined from standard soil moisture curve.

-- No reading.

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APPENDIX TABLE 17. SALINITY MEASUREMENTS (EC) OF CORE SAMPLES FROM THE LOW-ELEVATION STUDY SITE, AUGUST 1978.

TOSCO Spent Shale

Depth (cm)	North Aspect							South Aspect						
	30 cm Soil Cover		15 cm Soil Cover		TOSCO Spent Shale		Soil	30 cm Soil Cover		15 cm Soil Cover		TOSCO Spent Shale		Soil
	I	III	V	VII	IX	XI	XIII	II	IV	VI	VII	X	XII	XIV
15	1.0*	1.2	1.2	6.0	5.8	5.8	0.7	2.2	1.0	1.2	2.2	6.0	6.8	1.3
30	1.0	2.6	6.6	6.3	7.6	6.3	0.6	4.7	2.9	7.8	6.2	7.6	10.5	1.0
45	6.4	9.4†	7.4	5.6	8.6	7.8	1.0	10.0	9.6	10.6	8.1	8.8	12.6	0.8
60	8.9	†	7.5	4.7	8.6	7.8	0.8	11.0	11.6	11.6	11.4	8.8	11.8	1.1
75	10.5	†	8.4	8.0	9.5	8.0	1.8	11.0	12.4	12.0	8.6	8.8	11.5	1.1
90	12.6	11.4	9.6	8.1	8.6†	7.0	1.0	13.0	12.8	11.6	6.8	9.0	10.8	1.3
105	14.0	15.0	9.6	8.9	†	--	0.9	14.5	13.2	10.2	8.3	9.2	10.3	--
120	14.5	8.0	8.8	6.0	8.4	--	0.9	14.5	12.2	11.5	7.2	10.8	11.3	--
135	8.8	10.2	--	9.4	--	--	--	14.2	13.0	11.8	8.3	10.6	10.8	--
150	9.4	12.0	--	--	--	--	--	15.5	11.0	11.5	8.7	9.6	11.0	--
155	9.5	10.2	--	--	--	--	--	--	--	--	--	--	--	--

USBM Spent Shale

Depth (cm)	North Aspect							South Aspect						
	60 cm Soil Cover		15 cm Soil Cover		USBM Spent Shale		Soil	60 cm Soil Cover		15 cm Soil Cover		USBM Spent Shale		Soil
	13	11	9	7	5	3	1	14	12	10	8	6	4	2
15	2.0	1.5	1.4	1.3	0.6	1.5	0.6	2.0	1.7	2.2	1.8	2.6	1.8	1.1
30	1.2	1.3	1.3	1.4	1.8	1.5	1.6	1.8	1.9	1.7	2.0	2.2	1.6	1.2
45	1.8	1.3	3.9	1.9	1.7	2.0	0.6	1.8	1.7	4.0	2.5	2.1	2.5	1.2
60	0.9	1.6	4.4	2.0	2.4	1.5	1.7	1.4	2.5	3.9	4.6	2.1	2.4	2.0
75	1.9	2.0	5.2	2.7	3.1	2.5	0.6	3.8	5.4	4.5	3.6	3.9	5.1	--
90	2.4	4.1	5.2	5.3	2.6	2.6	0.7	4.1	4.2	3.8	3.5	4.4	3.5	--
105	2.2	6.0	3.5	7.2	3.9	6.8	0.6	6.8	5.8	4.1	3.5	3.9	5.6	--
120	--	5.6	4.1	5.0	5.7	2.6	0.9	7.2	6.2	3.8	5.2	10.5	5.1	--
135	3.0	6.0	3.4	5.9	6.9	4.6	1.0	5.9	--	4.2	--	--	5.6	--
150	4.5	7.5	7.8	4.9	6.0	6.9	0.7	6.8	5.4	4.9	7.4	--	6.0	--
155														

* EC values are in mmhos/cm @ 25°C measured on a 1:1 spent shale to water by weight sample.

† Denotes a composited sample.

-- No sample collected.

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APPENDIX TABLE 18. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE TOSCO AND USBM SHALE TREATMENTS, NORTH-ASPECT, LOW-ELEVATION STUDY SITE, 1979.

Species	NORTH ASPECT													
	30 cm/TOSCO		15 cm/TOSCO		TOSCO		60 cm/USBM		15 cm/USBM		USBM		Soil Control	
	I	III	V	VII	IX	XI	13	11	9	7	5	3	XIII	1
PERENNIAL GRASSES														
Western wheatgrass	416*	436	540	350	84	237	496	470	585	732	548	287	337	762
Bluebunch wheatgrass	-	-	-	31	-	-	-	-	-	-	-	-	-	-
Indian ricegrass	-	-	-	-	-	15	-	-	-	-	-	-	-	-
SHRUBS														
Fourwing saltbush	47	206	-	140	80	381	475	88	280	80	130	-	140	143
Rabbitbrush	-	-	-	-	-	-	-	-	10	-	-	-	-	-
Winterfat	-	32	86	76	91	-	68	200	112	117	-	225	39	138
FORBS														
Scarlet globemallow	-	5	5	13	-	-	-	10	-	25	-	-	8	-
OTHER SPECIES														
	-	-	-	-	-	-	-	-	-	-	-	-		
Cheatgrass	337	101	213	293	245	207	111	156	70	60	242	354	234	20
Dandelion	-	12	-	-	-	-	-	-	-	-	-	-	115	-
Dock	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kochia	3	-	-	-	-	-	-	-	-	-	-	-	30	-
Mustard	131	30	-	-	110	30	-	-	-	-	-	-	-	-
Russian thistle	-	-	-	-	-	-	-	-	-	-	-	32	-	-
													-	-
NO VEGETATIVE COVER	19	151	66	59	60	10	-	40	53	20	70	66	92	36
LITTER	72	124	164	118	373	225	35	61	65	76	115	156	80	-

* Values are in total cm of above ground vegetative cover by species. Each plot represents the total of three transect lines approximately 350 cm in length each. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 19. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE TOSCO AND USBM SHALE TREATMENTS, SOUTH-ASPECT, LOW-ELEVATION STUDY SITE, 1979.

	SOUTH ASPECT													
	30 cm/TOSCO		15 cm/TOSCO		TOSCO		30 cm/USBM		15 cm/USBM		USBM		Soil Control	
	II	IV	VI	VIII	X	XII	14	12	10	8	6	4	XIV	2
PERENNIAL GRASSES														
Western wheatgrass	277*	288	531	417	294	233	170	105	222	137	155	158	210	208
Bluebunch wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basin wildrye	121	133	65	48	17	15	-	45	59	10	10	-	-	67
Indian ricegrass	-	-	5	10	-	-	25	-	-	-	-	-	-	-
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SHRUBS														
Big sage	36	5	64	18	-	-	50	30	122	-	-	145	65	20
Fourwing saltbush	48	132	150	195	288	310	201	356	282	359	477	254	92	143
Winterfat	-	-	-	-	-	-	-	-	-	-	-	-	-	10
FORBS														
Utah sweetvetch	-	-	4	-	-	-	-	-	16	-	-	-	-	-
OTHER SPECIES														
Cheatgrass	224	215	-	-	-	-	82	305	281	309	65	85	308	455
Mustard	99	70	-	-	-	-	228	86	8	-	55	64	215	15
NO VEGETATIVE COVER	235	235	136	184	191	437	304	181	65	203	175	267	309	180
LITTER	28	44	127	208	292	75	10	10	34	47	115	66	45	20

* Values are in total cm of above ground vegetative cover by species. Each plot represents the total of three transect lines approximately 350 cm in length each. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 20. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE TOSCO SHALE TREATMENTS, NORTH-ASPECT, LOW-ELEVATION STUDY SITE, 1979.

Depth (cm)	30 cm Soil Cover/TOSCO												15 cm Soil Cover/TOSCO										
	I						III						V						VII				
	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17
15	10.0*	10.3	6.3	4.3	7.3	5.3	11.5	10.0	7.3	5.5	7.3	5.3	19.5	19.0	11.0	5.3	6.3	5.3	21.2	20.0	7.3	3.5	4.3
30	16.2	17.8	10.8	7.8	8.3	8.8	18.5	17.3	9.8	7.5	7.3	6.3	25.5	25.0	14.8	6.8	6.3	6.3	24.7	25.5	13.3	7.3	7.3
45	23.0	22.5	10.3	6.8	6.3	6.3	24.2	22.5	10.8	6.0	6.3	5.8	27.2	27.5	18.3	12.3	10.3	10.3	24.7	26.3	17.3	12.8	12.3
60	24.2	22.5	10.8	5.8	5.8	6.3	24.2	22.5	12.3	6.0	5.3	5.8	28.0	27.5	21.3	15.0	15.0	14.5	24.7	26.8	20.0	18.3	17.3
75	24.2	20.8	12.8	7.3	5.8	6.3	23.0	21.8	12.8	6.0	6.8	5.8	28.5	29.5	24.5	19.0	17.8	16.5	28.7	27.5	21.8	19.0	19.0
90	23.0	21.3	14.5	10.3	8.3	8.8	22.3	21.3	15.5	9.0	10.3	9.8	27.2	28.0	23.8	20.0	20.0	19.0	26.5	27.5	23.0	21.3	20.0
105	22.0	20.0	16.5	12.8	10.8	11.3	22.3	21.8	17.8	14.0	13.3	12.8	28.0	29.5	25.0	21.3	20.0	20.0	26.2	26.3	23.8	21.8	19.0
120	20.0	20.0	16.0	15.0	13.3	11.8	22.0	21.8	19.0	16.3	15.5	14.0	28.0	28.8	25.0	23.0	22.5	20.0	24.7	26.3	24.3	21.3	20.0
135	19.0	19.0	17.3	15.0	14.5	12.8	21.2	21.8	19.0	17.3	15.5	15.5	28.0	29.5	25.8	23.8	22.5	--	26.5	28.0	--	--	--
150	18.5	20.0	17.8	16.5	14.5	14.5	20.7	20.5	21.3	17.8	16.5	15.5	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	TOSCO Spent Shale												Soil Control					
	IX						XI						XIII					
	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10
15	21.2	21.8	9.0	2.8	3.3	3.3	21.2	21.3	10.8	2.8	7.5	7.3	14.0	14.0	8.0	6.0	7.3	6.8
30	25.5	26.3	16.5	7.0	6.5	6.5	27.2	26.0	16.5	8.0	12.8	11.8	18.3	17.8	11.5	10.0	9.3	9.3
45	27.2	28.8	20.0	13.5	12.0	11.5	28.5	26.8	20.8	13.5	16.0	10.8	20.7	21.3	13.8	13.0	11.3	11.8
60	28.0	28.0	22.5	17.8	14.8	16.0	29.2	27.0	22.5	17.8	19.0	11.3	21.7	21.7	14.8	13.5	12.8	12.3
75	28.0	28.0	23.8	19.5	18.3	17.0	29.2	29.3	23.8	19.0	19.5	17.8	23.0	21.8	16.0	13.5	12.8	12.3
90	29.2	29.5	24.5	20.0	19.0	17.8	27.2	28.0	23.0	20.0	20.0	19.0	24.2	23.0	19.0	14.0	13.3	12.3
105	28.0	27.5	24.5	20.5	19.0	18.3	28.5	28.0	24.3	21.3	20.0	20.0	22.3	23.0	20.8	15.3	13.3	12.8
120	28.5	--	--	--	--	18.0	28.0	--	24.3	20.5	--	--	21.7	21.8	20.8	15.8	13.3	13.3
135	--	--	--	--	--	--	--	--	--	--	--	--	--	21.8	--	--	--	--
150	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* Values are percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

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APPENDIX TABLE 21. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE TOSCO SHALE TREATMENTS, SOUTH-ASPECT, LOW-ELEVATION STUDY SITE, 1979.

Depth (cm)	30 cm Soil Cover/TOSCO												15 cm Soil Cover/TOSCO											
	II						IV						VI						VIII					
	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10
15	9.7*	14.0	7.5	5.0	6.8	6.8	16.2	15.3	8.3	6.0	8.5	7.5	13.5	13.0	6.8	4.8	6.3	5.3	17.2	18.3	6.5	4.0	6.5	5.0
30	15.0	16.5	10.5	10.0	9.0	8.5	18.2	21.8	10.8	9.0	9.5	8.5	22.5	23.0	11.5	7.0	7.3	7.3	26.0	24.3	9.5	5.5	6.5	6.5
45	24.2	21.3	12.0	9.5	8.5	8.0	23.0	21.8	10.3	7.0	8.5	7.5	25.5	25.5	16.0	10.0	8.8	9.3	26.0	26.3	14.3	8.3	9.0	8.0
60	24.2	21.8	14.3	9.0	8.5	7.5	25.0	21.3	12.3	6.5	7.5	6.0	26.0	26.8	19.0	15.3	14.0	12.8	27.2	25.5	18.3	12.8	11.5	11.5
75	23.7	20.0	14.3	9.0	8.0	7.5	23.7	20.0	14.0	7.5	7.5	6.8	24.7	27.8	20.8	17.3	16.5	15.5	27.2	26.8	20.8	16.3	14.3	13.8
90	20.7	20.8	15.5	11.0	10.0	8.5	21.7	20.0	14.5	11.0	10.0	8.5	27.2	27.8	23.0	19.0	17.8	17.3	26.7	26.8	22.5	17.8	17.0	16.0
105	19.5	18.3	15.5	13.5	12.0	11.5	21.2	21.3	16.5	13.5	13.3	12.0	24.7	25.3	24.5	19.5	19.0	17.3	26.7	26.8	24.5	21.3	19.0	17.8
120	19.5	20.0	17.8	15.8	14.8	13.8	21.7	22.5	17.8	16.8	14.8	14.3	26.0	24.8	24.5	20.0	19.0	19.0	26.7	28.0	25.0	21.8	20.8	19.5
135	19.0	20.0	19.0	17.3	16.0	14.8	21.2	--	18.3	17.3	16.0	14.8	25.5	25.5	23.8	20.0	19.5	18.3	--	--	--	--	--	--
150	19.5	19.5	--	17.3	16.5	14.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	TOSCO Spent Shale												Soil Control					
	X						XII						XIV					
	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10
15	20.7	19.5	7.3	4.3	7.3	6.3	21.7	20.5	7.5	3.3	3.3	3.3	11.5	12.3	8.5	6.0	6.8	6.5
30	23.0	23.8	16.0	13.5	14.5	13.3	24.2	24.3	12.0	7.5	8.0	6.8	16.7	16.5	11.5	11.0	11.0	11.5
45	23.5	24.3	18.3	15.8	16.5	17.3	24.7	24.8	17.8	12.0	11.5	12.0	18.5	16.5	14.3	12.5	12.0	12.8
60	26.0	26.3	21.3	19.5	18.3	19.0	25.5	25.5	20.0	15.8	14.8	13.8	19.5	17.8	13.3	12.0	12.8	12.8
75	26.0	26.8	22.5	20.0	19.5	20.0	25.5	25.5	21.3	17.3	17.0	17.0	22.0	20.8	13.8	12.5	12.0	12.8
90	25.5	26.8	22.5	20.5	19.5	19.5	25.5	25.5	22.5	20.0	19.0	17.0	23.5	23.0	14.8	12.5	12.8	12.8
105	25.5	26.3	23.0	20.5	20.0	20.0	25.5	26.0	23.8	21.3	19.5	18.3	22.3	22.5	17.8	13.5	12.8	12.0
120	24.7	25.5	23.0	21.3	20.0	20.0	--	--	--	--	--	--	23.0	23.0	21.3	17.8	15.5	13.8
135	--	--	--	--	--	--	--	--	--	--	--	--	22.0	22.5	22.5	17.8	16.0	15.5
150	--	--	--	--	--	--	--	--	--	--	--	--	22.0	23.0	22.5	19.5	16.5	16.0

* Values are percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

APPENDIX TABLE 22. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE USBM SHALE TREATMENTS, NORTH-ASPECT, LOW-ELEVATION STUDY SITE, 1979.

Depth (cm)	60 cm Soil Cover/USBM												15 cm Soil Cover/USBM											
	13						11						9						7					
	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10
15	11.8*	11.0	6.8	4.8	7.5	5.8	12.3	15.5	8.0	7.3	8.0	6.8	11.3	13.5	7.8	5.5	8.0	6.5	11.3	10.5	6.3	4.8	6.5	5.3
30	18.3	17.8	11.5	10.0	10.0	9.3	22.5	19.0	11.5	11.3	10.5	9.5	21.2	21.8	13.3	10.5	10.5	11.0	23.7	24.5	12.3	10.0	10.0	11.3
45	21.2	19.5	12.0	10.0	9.5	9.3	23.7	19.5	13.3	11.3	10.5	10.5	23.7	24.8	17.3	12.0	12.0	12.0	26.2	26.5	17.3	12.5	12.0	11.3
60	20.0	21.8	14.8	11.5	11.5	10.3	25.5	23.8	16.5	13.3	12.0	12.0	25.0	24.8	17.8	12.5	11.5	11.0	25.5	25.8	19.0	14.5	13.8	12.3
75	20.7	23.0	16.5	13.0	11.5	11.3	25.5	26.3	20.0	16.0	13.8	13.3	26.2	21.3	18.3	13.0	12.0	11.5	24.3	25.0	19.0	14.5	12.8	12.3
90	22.5	22.5	18.3	13.0	11.5	11.3	25.0	25.5	20.8	15.5	13.8	13.3	26.2	21.8	19.5	14.0	12.3	12.8	24.3	23.8	20.0	15.8	13.8	12.3
105	23.7	22.5	19.0	12.5	11.5	11.3	26.2	23.8	19.5	16.5	13.3	13.3	26.8	23.5	20.8	15.8	14.3	13.3	24.3	23.8	20.8	17.3	14.8	13.3
120	23.0	21.8	20.0	14.0	12.0	12.8	26.2	25.0	20.0	17.3	14.8	13.8	26.2	24.8	21.3	17.3	14.8	14.3	25.0	24.5	20.8	18.3	15.5	14.5
135	21.8	20.5	20.8	16.3	14.3	14.0	25.0	24.5	21.3	19.0	16.0	14.8	26.2	24.8	20.8	18.3	16.5	15.5	26.2	26.5	21.8	20.0	17.8	16.0
150	22.5	21.8	20.0	16.8	14.8	14.5	--	--	--	--	--	--	--	--	--	--	--	--	27.5	27.0	--	21.8	19.0	--

Depth (cm)	USBM Spent Shale												Soil Control					
	5						3						1					
	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10
15	12.8	18.3	9.3	7.0	8.0	6.3	10.3	16.5	9.3	5.5	6.3	5.5	11.3	13.3	7.8	6.0	8.0	6.8
30	23.0	19.5	14.5	11.0	10.5	9.3	19.0	22.5	15.0	10.0	9.3	10.0	18.3	20.0	10.8	10.3	10.0	9.8
45	24.3	22.5	17.8	11.5	11.0	10.8	20.7	25.5	17.3	11.5	10.8	11.0	20.0	21.3	12.3	10.8	11.0	11.3
60	24.3	26.3	19.0	13.5	12.0	11.8	24.3	25.5	18.3	12.5	11.3	11.5	23.0	17.8	12.3	10.3	10.5	10.3
75	24.3	26.8	21.8	15.8	13.8	14.0	25.0	26.3	21.3	15.3	12.8	13.8	23.7	21.3	14.5	11.3	10.5	10.8
90	23.7	26.8	22.5	15.3	[illegible]	12.3	26.2	24.3	21.4	16.3	14.5	14.8	23.7	22.5	17.3	12.8	11.5	11.3
105	25.0	26.3	20.8	14.0	12.8	11.8	25.0	25.5	20.8	16.8	15.0	14.8	24.3	22.5	17.8	12.3	12.0	10.8
120	24.3	26.3	21.8	15.8	13.3	12.3	24.3	26.7	21.8	17.8	15.5	15.5	23.7	21.3	18.3	14.3	12.8	11.8
135	25.0	27.5	22.5	20.0	15.5	14.0	24.3	23.8	21.3	17.3	15.5	15.5	23.0	21.8	19.5	16.8	15.5	14.5
150	--	--	--	--	--	--	--	--	--	--	--	--	23.0	--	--	--	--	--

* Values are percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

APPENDIX TABLE 23. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE USBM SHALE TREATMENTS, SOUTH-ASPECT, LOW-ELEVATION STUDY SITE, 1979.

Depth (cm)	60 cm Soil Cover/USBM												15 cm Soil Cover/USBM											
	14						12						10						8					
	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10
15	9.7*	12.3	7.8	6.0	6.8	6.3	16.0	13.0	7.3	6.0	6.8	5.8	16.2	11.0	6.0	5.5	6.5	5.8	10.0	10.3	7.5	5.0	5.5	6.5
30	16.7	13.3	9.8	9.3	9.5	8.3	21.8	16.3	10.3	9.0	9.0	9.3	21.2	21.3	12.0	11.0	10.0	9.3	20.0	20.0	13.3	10.8	10.5	10.0
45	19.0	14.0	10.8	10.3	10.5	10.3	23.7	15.8	12.3	10.0	9.5	9.8	21.8	21.3	13.8	10.5	11.0	10.3	21.2	21.3	16.5	12.3	12.8	12.8
60	19.5	14.5	12.3	10.3	10.5	10.3	23.7	18.3	12.8	10.5	10.5	10.3	21.2	21.8	14.8	10.5	10.0	10.3	23.0	21.8	17.8	12.3	12.8	12.8
75	21.2	15.0	16.5	12.8	12.0	11.8	24.3	21.3	14.0	12.0	11.5	10.8	21.8	21.3	16.0	11.0	10.0	9.8	24.2	25.0	20.8	15.8	13.8	12.0
90	21.8	21.8	19.0	16.3	14.8	13.3	25.0	21.8	16.0	13.0	12.8	11.8	20.0	19.0	15.5	10.0	9.5	9.8	24.2	24.3	20.8	15.3	13.8	13.3
105	22.5	25.0	21.3	17.8	16.0	14.5	25.0	21.8	17.8	13.5	12.8	12.3	20.6	20.0	17.8	12.0	10.5	11.3	24.2	23.8	21.3	15.8	14.3	13.8
120	22.5	25.0	22.5	19.0	17.0	15.0	25.0	21.8	17.8	13.0	12.8	12.3	23.0	23.5	20.8	14.0	12.8	12.8	24.2	24.3	21.3	16.8	14.8	13.8
135	23.7	25.5	23.8	19.0	18.3	16.0	24.3	23.0	19.0	14.0	12.0	12.3	23.5	24.3	20.8	15.8	13.8	12.8	24.2	--	22.5	17.3	16.0	15.5
150	23.0	25.5	22.5	19.5	17.8	--	--	25.5	20.0	16.3	14.3	14.0	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	USBM Spent Shale												Soil Control					
	6						4						2					
	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10	4/25	5/16	6/15	7/18	8/17	9/10
15	9.7	18.3	9.3	5.5	6.3	5.3	10.3	15.5	8.5	6.0	7.5	6.3	9.2	11.3	6.8	6.0	7.5	6.8
30	21.8	20.8	12.8	10.8	9.8	9.3	17.2	21.8	14.3	12.0	11.0	10.3	14.5	16.5	11.5	9.8	10.0	9.5
45	22.5	22.5	14.5	11.3	10.3	10.3	18.3	23.8	17.0	12.0	11.5	11.3	17.2	16.0	12.8	10.8	11.5	10.5
60	21.8	21.8	15.5	11.8	11.3	10.8	23.7	23.8	17.8	14.0	12.8	12.3	19.5	18.3	12.8	11.3	11.0	10.5
75	21.8	21.3	16.0	12.3	11.8	11.8	25.0	23.8	20.0	16.3	14.8	14.0	23.8	16.5	13.3	11.3	11.0	10.5
90	20.7	20.8	17.8	15.8	12.8	12.3	26.2	23.0	21.3	17.8	17.0	15.5	25.5	20.0	14.3	11.3	11.5	10.5
105	21.2	22.5	18.3	16.8	14.0	13.3	26.2	23.8	21.3	19.0	17.0	16.5	25.0	21.3	16.5	11.8	12.0	11.0
120	23.7	22.5	20.0	20.0	15.5	15.5	23.7	25.0	22.0	19.5	17.0	16.5	25.5	22.5	19.0	13.3	13.3	12.8
135	23.7	24.3	21.3	--	16.5	16.5	23.7	25.5	23.0	20.0	19.0	17.8	26.2	23.8	21.3	19.0	17.0	14.8
150	--	--	--	--	--	--	25.0	--	--	--	--	--	27.5	--	22.0	17.8	16.0	15.5

* Values are percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

APPENDIX TABLE 24. SALINITY MEASUREMENTS (EC) OF CORE SAMPLES FROM THE TOSCO SHALE TREATMENTS AT THE LOW-ELEVATION STUDY SITE, 1979.

	North Aspect						
Depth (cm)	30 cm Soil Cover/ TOSCO		15 cm Soil Cover/ TOSCO		TOSCO Spent Shale		Soil Control
	I	III	V	VII	IX	XI	XIII
Surface	0.8*	0.8	0.6	0.8	1.5	2.0	1.4
15	1.0	0.8	0.5	2.3	2.3	3.5	0.8
30	0.8	0.4	2.5	2.9	2.6	6.4	0.4
45	2.4	1.8	2.7	4.4	5.7	8.4	0.4†
60	2.8	2.2	5.0	4.9	4.7	7.2	†
75	4.3	4.5	4.6	6.3	5.4	7.0	0.4†
90	5.8	6.0	3.3	6.9	6.6	6.2	†
105	5.8	6.9	4.5	6.8	5.9	5.6	--
120	5.9	4.9	5.8	6.3	6.8	5.4	--

	South Aspect						
Depth (cm)	30 cm Soil Cover/ TOSCO		15 cm Soil Cover/ TOSCO		TOSCO Spent Shale		Soil Control
	II	IV	VI	VIII	X	XII	XIV
Surface	0.8	3.0	0.9	0.6	1.5	2.2	0.6
15	0.5	1.0	0.5	0.6	2.4	2.2	0.4
30	1.3	0.5	2.4	2.1	4.2	2.5	0.6
45	3.1	2.5	3.8	2.4	4.1	3.8	0.7
60	3.1	3.0	7.0	3.2	4.2	4.0	0.6
75	4.2	5.5	5.2	4.2	5.3	3.3	--
90	9.0	5.5	4.2	3.9	5.0	3.3	--
105	8.8	9.4	2.9	4.1	5.0	4.5	--
120	12.1	6.3	4.7	5.8	6.1	4.2	--

† Denotes a composited sample.

-- No sample

* EC values are in mmhos/cm @25°C measured from a 1:1 spent shale to water by weight sample.

APPENDIX TABLE 25. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE TOSCO AND USBM SHALE TREATMENTS, NORTH-ASPECT, LOW-ELEVATION STUDY SITE, 1980.

	North Aspect													
	30 cm Soil/ TOSCO		15 cm Soil/ TOSCO		TOSCO Spent Shale		60 cm Soil/ USBM		15 cm Soil/ USBM		USBM Spent Shale		Soil Control	
	I	III	V	VII	IX	XI	13	11	9	7	5	3	XIII	1
PERENNIAL GRASSES														
Western wheatgrass	288*	299	392	319	92	140	220	158	217	301	156	100	324	298
Bluebunch wheatgrass	-	2	1	-	-	2	11	-	7	16	75	7	4	-
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SHRUBS														
Fourwing saltbush	109	330	-	184	308	92	183	237	236	89	265	267	347	218
Winterfat	2	34	4	21	122	75	58	108	37	35	67	57	24	-
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FORBS														
Scarlet globemallow	-	-	-	5	-	-	-	2	-	-	-	-	5	-
OTHER SPECIES														
Cheatgrass	124	124	97	132	122	80	113	186	101	42	98	196	140	52
Mustard	8	6	-	-	44	48	-	-	-	-	-	3	2	-
Aegilops	3	-	-	-	-	2	-	-	-	-	-	-	-	5
Dock	-	-	6	-	-	-	-	-	-	-	-	-	4	-
Prickly lettuce	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salsify	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sticktight	-	-	-	-	-	-	-	-	-	2	-	-	-	-
NO VEGETATIVE COVER	20	24	32	64	38	71	-	15	37	57	24	98	15	28
LITTER	433	348	508	404	382	394	-	351	481	511	430	354	258	459

* Values are in total centimeters of aboveground vegetative cover by species. Each plot represents a total of three transect lines approximately 350 cm in length each. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 26. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE TOSCO AND USBM SHALE TREATMENTS, SOUTH-ASPECT, LOW-ELEVATION STUDY SITE, 1980.

Species	South Aspect													
	30 cm Soil/ TOSCO		15 cm Soil/ TOSCO		TOSCO Spent Shale		60 cm Soil/ USBM		15 cm Soil/ USBM		USBM Spent Shale		Soil Control	
	II	IV	VI	VIII	X	XII	14	12	10	8	6	4	XIV	2
PERENNIAL GRASSES														
Western wheatgrass	21*	97	109	152	62	67	90	108	63	33	71	40	202	177
Bluebunch wheatgrass	-	-	-	-	-	-	-	9	-	-	-	-	-	3
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	38
SHRUBS														
Fourwing saltbush	589	513	345	204	254	237	388	303	363	361	320	273	2	157
Winterfat	25	16	39	34	20	208	132	61	39	230	53	38	-	78
Rabbitbrush	-	-	-	3	-	-	-	-	2	-	-	-	-	-
FORBS														
Scarlet globemallow	5	-	10	10	-	-	-	-	4	-	-	-	21	-
OTHER SPECIES														
Cheatgrass	301	256	197	182	89	112	182	159	170	147	223	183	117	109
Mustard	71	38	12	12	201	55	-	-	2	-	-	4	10	15
Aegilops	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Dock	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Prickly lettuce	-	-	-	-	6	-	-	-	-	-	-	-	-	-
Salsify	-	-	-	-	-	-	-	-	-	-	-	-	2	-
Sticktight	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO VEGETATIVE COVER	28	44	75	76	72	58	47	59	74	117	105	201	387	164
LITTER	196	230	332	383	319	331	284	402	345	239	293	305	240	419

* Values are in total centimeters of aboveground vegetative cover by species. Each plot represents a total of three transect lines approximately 350 cm in length each. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 27. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE TOSCO SHALE TREATMENTS, NORTH-ASPECT, LOW-ELEVATION STUDY SITE, 1980.

	30 cm Soil Cover/TOSCO										15 cm Soil Cover/TOSCO									
	I					III					V					VII				
	4/15	5/27	6/21	8/22	9/13	4/15	5/27	6/21	8/22	9/13	4/15	5/27	6/21	8/22	9/13	4/15	5/27	6/21	8/22	9/13
15	13.3	9.8	2.5	0.8	1.3	14.0	9.5	2.5	0.8	1.3	20.0	19.5	2.8	0.8	1.0	20.8	19.5	1.0	0.8	0.3
30	18.3	14.3	8.5	6.0	5.0	19.0	15.5	7.5	6.0	4.5	24.3	23.0	7.3	4.0	3.5	25.0	24.5	6.0	3.3	2.8
45	20.0	18.3	8.0	6.8	6.3	20.8	19.0	7.5	6.0	6.0	26.8	25.8	10.8	5.0	4.5	25.0	25.0	11.5	4.8	4.5
60	18.3	17.8	6.5	6.0	6.0	19.0	16.5	6.5	5.5	4.5	26.3	26.5	15.5	5.5	5.3	25.5	24.5	16.0	7.5	8.3
75	17.3	17.8	6.5	5.0	5.5	17.3	16.5	6.5	5.0	5.0	25.5	27.0	19.0	9.3	8.5	25.5	27.0	19.5	13.5	13.0
90	15.5	16.0	7.5	5.5	5.5	16.5	17.0	8.5	5.0	4.5	26.3	27.0	20.8	13.0	12.3	24.3	27.0	21.3	15.5	14.5
105	14.5	15.3	10.5	7.3	6.3	15.5	17.0	12.0	6.8	7.3	25.5	27.8	21.8	15.0	13.5	23.0	25.8	22.5	16.0	16.0
120	14.0	14.8	11.0	8.8	8.8	14.5	16.5	15.5	10.5	10.5	23.8	28.3	22.5	16.5	16.0	23.8	24.5	23.0	17.3	16.0
135	13.3	13.5	12.0	9.3	9.3	14.5	16.0	15.5	11.5	11.5	25.0	-	23.0	18.3	17.8	23.8	-	23.0	17.3	16.0
150	12.3	14.3	13.3	9.8	9.8	14.5	16.0	16.0	13.0	12.0	-	-	24.3	19.3	17.8	-	-	24.5	18.8	17.3

Depth (cm)	TOSCO Spent Shale										Soil Control				
	IX					XI					XIII				
	4/15	5/27	6/21	8/22	9/13	4/15	5/27	6/21	8/22	9/13	4/15	5/27	6/21	8/22	9/13
15	20.0	21.3	1.0	0.3	0.8	21.3	20.8	1.5	0.8	1.3	17.8	13.3	2.0	0.8	1.3
30	23.8	23.3	7.5	2.8	2.0	25.0	25.0	9.5	3.0	2.5	19.5	16.0	9.0	6.3	6.5
45	25.5	26.0	14.3	5.0	4.8	26.3	25.5	15.5	6.0	5.0	20.8	20.8	12.0	8.3	9.0
60	26.3	26.5	17.8	6.8	7.5	26.3	26.3	18.3	10.0	10.5	21.8	23.0	13.8	10.0	11.0
75	25.5	28.0	19.5	11.5	11.5	25.5	26.3	21.3	13.5	14.0	23.0	24.5	14.8	11.5	11.5
90	25.0	27.3	22.0	15.0	15.0	24.3	25.5	22.5	16.0	15.5	22.5	23.0	15.5	11.0	12.0
105	23.0	26.0	22.5	16.5	15.5	24.3	26.3	23.8	17.8	16.0	18.3	22.5	17.0	11.0	12.0
120	23.8	-	23.0	16.5	16.0	24.3	25.5	23.8	17.8	16.5	14.5	17.8	17.0	12.0	12.5
135	-	-	-	17.3	16.5	23.8	-	23.8	17.8	17.8	14.0	-	16.5	11.5	11.5
150	-	-	-	-	-	-	-	-	-	-	-	-	-	11.0	11.5

APPENDIX TABLE 28. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE TOSCO SHALE TREATMENTS, SOUTH-ASPECT, LOW-ELEVATION STUDY SITE, 1980.

Depth (cm)	30 cm Soil Cover/TOSCO										15 cm Soil Cover/TOSCO									
	II					IV					VI					VIII				
	4/15	5/27	6/21	8/22	9/13	4/15	5/27	6/21	8/21	9/13	4/15	5/27	6/21	8/22	9/13	4/15	5/27	6/21	8/22	9/13
15	12.3	10.0	2.0	1.3	1.3	15.5	12.8	1.5	0.8	1.3	12.8	12.8	1.5	0.3	0.3	19.0	16.0	1.5	0.8	0.3
30	16.5	14.8	8.5	5.5	6.0	19.0	14.8	6.8	6.3	6.3	23.8	22.5	7.8	4.5	2.8	26.3	24.5	6.0	3.8	3.3
45	25.0	20.8	12.0	7.3	7.3	22.5	19.0	10.5	6.8	7.3	26.3	23.0	17.8	5.0	5.0	26.3	25.8	8.0	4.5	4.5
60	24.3	21.3	13.8	6.3	6.3	21.8	20.8	16.0	5.5	5.5	26.8	24.5	19.5	5.5	6.3	27.5	25.0	10.5	5.5	5.5
75	20.0	18.3	13.3	6.0	6.0	21.3	19.0	19.0	5.0	5.0	27.5	26.5	22.5	8.3	8.3	26.8	25.8	16.0	6.8	6.8
90	19.0	17.8	14.3	6.0	6.0	21.8	19.0	21.3	5.5	5.0	26.8	25.8	23.0	12.0	13.0	27.5	27.0	19.5	10.0	10.0
105	17.8	18.3	13.8	6.3	7.3	20.0	19.0	22.5	6.3	6.3	26.8	26.5	22.5	14.5	14.5	27.5	28.3	21.3	12.5	13.0
120	20.0	20.8	14.3	9.3	9.3	20.0	19.5	23.0	9.8	9.3	26.3	25.8	23.0	16.0	15.5	28.0	27.8	23.0	14.0	14.5
135	19.0	20.8	18.3	12.0	11.5	20.8	20.8	-	6.3	12.0	25.0	25.0	23.0	16.0	16.0	28.0	-	24.5	16.5	16.0
150	17.8	20.8	20.8	14.0	13.0	-	-	-	13.0	13.0	-	-	-	17.3	16.0	-	-	24.5	18.3	17.3

Depth (cm)	TOSCO Spent Shale										Soil Control				
	X					XII					XIV				
	4/15	5/27	6/21	8/22	9/13	4/15	5/27	6/21	8/21	9/13	4/15	5/27	6/21	8/22	9/13
15	22.5	19.0	1.5	0.3	0.3	25.0	20.8	3.0	0.8	0.3	15.5	10.8	3.3	0.8	0.3
30	24.3	23.0	6.5	3.8	4.5	25.5	23.8	10.0	3.0	2.5	19.5	15.0	9.8	5.0	5.3
45	25.5	23.8	9.0	12.0	11.0	26.3	24.5	9.5	5.8	5.5	20.8	16.0	10.3	9.3	9.0
60	26.3	25.8	13.3	14.5	13.0	26.3	25.0	8.0	8.5	8.3	20.8	16.0	11.3	11.0	10.5
75	26.3	25.8	16.5	16.5	14.5	26.3	25.0	8.0	12.5	11.0	21.8	17.8	11.3	10.0	11.0
90	26.3	25.8	20.8	18.3	17.3	26.3	26.5	9.0	14.0	14.0	23.8	19.5	11.8	11.0	11.0
105	25.5	26.5	22.0	18.3	17.3	25.5	25.8	11.5	16.0	15.0	23.8	20.0	14.0	11.0	11.5
120	25.5	25.8	23.0	18.8	16.5	25.5	-	15.5	16.5	16.0	22.5	21.3	16.0	10.5	11.0
135	25.0	-	22.5	19.5	17.3	-	-	16.5	17.3	17.8	22.5	20.8	17.8	11.0	11.5
150	-	-	23.0	18.8	18.3	-	-	19.0	-	-	21.3	21.3	20.8	12.0	12.5

APPENDIX TABLE 29. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE USBM SHALE TREATMENTS, NORTH-ASPECT, LOW-ELEVATION STUDY SITE, 1980.

Depth (cm)	60 cm Soil Cover/USBM										15 cm Soil Cover/USBM									
	13					11					9					7				
	4/15	5/27	6/21	8/22	9/13	4/15	5/27	6/21	8/22	9/13	4/15	5/27	6/21	8/22	9/13	4/15	5/27	6/21	8/22	9/13
15	16.0	10.0	2.8	1.3	1.5	17.8	14.3	2.5	0.8	0.3	14.5	14.3	2.0	0.3	1.3	13.3	12.0	2.5	0.3	1.0
30	20.8	16.0	9.8	6.5	6.5	20.0	18.3	9.3	8.5	4.5	23.0	21.3	9.0	5.8	7.3	21.8	20.8	9.3	5.5	5.3
45	20.8	18.3	11.3	8.5	8.5	20.0	18.3	11.8	9.0	8.3	23.0	22.0	13.0	10.0	9.3	23.8	23.0	13.3	9.8	9.0
60	22.0	20.8	12.3	9.0	8.5	20.0	20.8	12.3	9.5	8.8	21.8	22.5	13.5	10.5	10.0	23.0	23.0	16.5	11.0	9.8
75	22.0	21.3	13.3	10.0	10.0	21.3	22.5	15.0	12.0	10.0	21.8	22.0	14.0	10.5	10.0	21.3	21.3	17.3	11.0	9.8
90	19.5	20.8	14.0	10.0	10.5	20.0	22.0	17.3	11.5	11.0	20.0	21.3	15.3	10.0	10.5	19.0	22.0	17.3	10.5	9.8
105	17.8	20.8	15.0	9.5	10.5	16.5	20.8	16.5	11.0	10.5	19.5	22.0	16.3	11.5	10.5	16.0	21.3	17.8	11.0	10.8
120	14.8	19.5	15.5	10.0	10.0	15.0	17.8	17.3	12.0	10.5	19.0	22.5	17.3	11.5	11.0	15.0	20.8	18.3	12.0	11.8
135	13.8	14.8	16.5	11.0	11.0	14.0	16.0	17.3	12.5	11.5	16.5	21.3	19.0	12.0	11.5	16.0	20.8	19.0	13.5	11.8
150	14.3	13.8	16.0	12.5	11.5	-	-	16.5	14.0	11.0	-	-	19.5	12.5	12.5	16.5	22.0	20.8	14.0	12.3

Depth (cm)	USBM Spent Shale										Soil Control				
	5					3					1				
	4/15	5/27	6/21	8/22	9/13	4/15	5/27	6/21	8/22	9/13	4/15	5/27	6/21	8/22	9/13
15	17.0	16.5	3.3	1.3	1.3	18.3	17.8	2.5	0.8	1.3	16.0	13.0	2.0	0.8	1.3
30	20.8	21.3	11.0	8.0	6.5	22.5	21.3	11.5	5.0	5.8	20.8	17.0	9.0	6.8	5.5
45	22.0	21.3	14.5	10.0	9.5	22.5	23.3	15.5	7.8	8.5	23.0	21.3	11.0	8.8	8.8
60	23.0	22.0	15.8	10.0	9.5	22.5	24.0	16.0	9.3	8.5	20.8	20.0	12.8	9.3	9.8
75	24.5	25.3	18.3	10.5	11.0	22.5	23.3	17.8	9.8	9.5	22.0	21.3	12.0	8.8	9.3
90	23.0	25.3	19.0	13.0	12.0	22.5	23.3	18.3	10.5	10.0	22.5	22.8	14.8	8.8	9.3
105	22.5	24.5	18.3	11.5	12.5	21.3	23.3	19.0	11.0	11.0	20.8	22.8	15.5	10.5	9.3
120	21.3	24.0	17.8	11.0	12.0	20.8	24.5	20.8	12.5	11.5	15.5	19.5	14.3	8.8	9.8
135	18.3	24.0	19.5	11.5	11.5	18.3	24.5	21.3	13.0	12.5	14.8	17.0	14.8	10.0	9.3
150	-	-	20.0	13.5	12.5	-	-	20.8	13.0	13.0	14.8	-	13.8	11.0	9.3

APPENDIX TABLE 30. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE USBM SHALE TREATMENTS, SOUTH-ASPECT, LOW-ELEVATION STUDY SITE, 1980.

Depth (cm)	60 cm Soil Cover/USBM										15 cm Soil Cover/USBM									
	14					12					10					8				
	4/15	5/27	6/21	8/22	9/13	4/15	5/27	6/21	8/22	9/13	4/15	5/27	6/21	8/22	9/13	4/15	5/27	6/21	8/22	9/13
15	14.3	10.3	3.3	1.3	1.5	14.0	11.5	2.3	1.3	1.3	13.3	10.0	1.5	0.3	0.3	12.3	9.3	2.0	0.8	1.3
30	19.5	15.3	9.3	6.8	6.0	19.0	17.0	8.0	6.0	6.0	21.3	20.8	9.0	4.5	4.5	19.5	17.8	10.8	5.8	5.5
45	20.8	17.8	10.8	8.3	8.5	19.5	17.0	10.5	8.3	7.3	23.8	22.0	13.0	8.8	8.3	20.8	21.3	15.0	10.0	9.8
60	21.3	19.5	11.3	9.3	9.0	22.5	20.8	11.5	8.8	8.8	23.0	20.8	15.3	9.3	9.3	22.5	22.8	15.5	11.5	10.0
75	24.5	24.0	13.3	9.3	9.5	24.3	22.0	12.5	8.8	10.0	21.3	20.8	14.5	9.3	9.3	23.8	25.3	17.8	11.0	10.0
90	25.0	24.0	16.0	10.0	10.5	25.0	23.8	15.8	10.5	10.0	20.8	19.5	14.0	8.3	8.8	23.8	24.5	19.0	11.5	11.0
105	25.0	24.5	20.8	11.5	11.5	24.3	23.0	15.8	10.5	10.5	20.8	20.8	14.0	8.3	8.3	23.8	24.5	20.0	12.0	11.0
120	27.0	26.5	20.8	13.0	12.5	22.5	21.3	15.3	11.0	10.5	23.8	23.8	15.8	9.8	9.8	23.8	24.5	20.0	12.5	11.5
135	26.5	26.5	21.8	13.5	13.5	23.0	22.0	17.3	10.5	10.5	23.8	24.5	19.0	11.0	10.5	24.3	25.3	20.8	12.5	12.0
150	27.8	26.5	22.5	14.5	14.0	25.5	-	17.3	11.0	10.5	-	-	20.5	11.5	11.5	-	-	21.8	13.0	13.0

Depth (cm)	USBM Spent Shale										Soil Control				
	6					4					2				
	4/15	5/27	6/21	8/22	9/13	4/15	5/27	6/21	8/22	9/13	4/15	5/27	6/21	8/22	9/13
15	18.3	16.0	2.5	0.8	1.3	19.0	16.0	2.0	0.8	1.3	14.5	10.5	2.5	0.8	0.3
30	21.8	20.8	11.5	6.3	5.5	21.8	22.5	12.0	7.0	7.3	18.3	15.5	10.0	6.8	5.3
45	22.5	22.0	15.5	9.0	9.3	22.5	23.0	16.0	10.5	9.8	20.8	19.0	12.8	9.3	8.5
60	23.0	22.0	16.5	9.8	10.0	23.8	23.0	17.0	12.0	10.5	20.0	20.8	13.3	9.8	9.0
75	22.5	20.8	17.0	10.3	10.0	23.8	23.8	18.3	12.5	12.0	20.8	20.8	13.3	10.0	9.3
90	20.8	20.8	18.3	11.8	11.0	24.3	24.5	19.5	13.5	13.0	20.8	19.5	13.8	10.0	9.8
105	21.3	22.0	17.8	11.8	12.0	25.0	24.5	21.3	15.0	14.5	21.8	21.3	13.8	9.8	9.0
120	22.5	23.0	20.8	12.3	12.0	25.0	25.0	22.0	14.5	15.0	22.5	22.0	15.5	10.0	9.3
135	24.3	24.5	21.3	13.5	13.5	25.5	24.5	23.0	16.5	16.0	24.3	23.0	18.3	10.5	9.8
150	-	-	23.8	15.0	16.0	25.5	-	23.0	17.3	17.3	22.5	21.3	23.0	11.5	10.8

APPENDIX TABLE 31. SALINITY MEASUREMENTS (EC) OF CORE SAMPLES FROM THE TOSCO SHALE TREATMENTS AT THE LOW-ELEVATION STUDY SITE, SEPTEMBER, 1980.

Depth (cm)	NORTH ASPECT													
	TOSCO Spent Shale				15 cm Soil Cover/TOSCO				30 cm Soil Cover/TOSCO				Soil	
	I		III		V		VII		IX		XI		XIII	
	pH	EC	pH	EC	pH	EC	pH	EC	pH	EC	pH	EC	pH	EC
		mmhos/cm		mmhos/cm		mmhos/cm		mmhos/cm		mmhos/cm		mmhos/cm		mmhos/cm
Surface	7.4	0.7	7.2	0.3	7.3	0.3	6.8	0.5	6.8	1.1	6.5	0.5	7.2	0.4
15	7.5	0.4	7.3	0.3	7.3	0.4	7.1	1.6	7.2	2.3	7.1	2.5	7.6	0.3
30	7.6	0.4	7.4	1.2	7.4	2.3	7.7	2.8	7.4	2.6	7.3	2.8	7.9	0.3
45	7.5	2.5	7.4	3.2	7.7	3.3	7.9	4.9	7.9	5.0	7.7	5.1	7.8	0.4
60	7.6	2.6	7.9	5.9	8.1	7.6	8.0	4.8	7.8	4.5	7.8	4.9	7.8	0.5
75	8.1	5.7	8.3	12.6	8.2	8.8	8.0	6.0	8.0	5.6	7.8	6.0	7.9	0.5
90	8.2	7.4	8.3	14.7	8.1	6.8	8.1	6.2	8.0	5.0	7.9	6.1	8.1	0.4
105	8.3	11.4	8.4	15.5	8.1	7.0	8.2	8.0	8.1	6.7	7.9	6.2	8.1	0.4
120	8.5	11.2	8.4	14.4	8.1	6.8	8.2	7.4	8.1	7.4	7.9	7.0	-	-
135	8.4	6.0	8.3	10.0	8.1	7.2	8.1	7.0	8.1	7.8	7.8	7.4	-	-
150	8.5	9.8	8.2	8.9	8.0	6.8	8.1	6.6	-	-	-	-	-	-

Depth (cm)	SOUTH ASPECT													
	TOSCO Spent Shale				15 cm Soil Cover/TOSCO				30 cm Soil Cover/TOSCO				Soil	
	II		IV		VI		VIII		X		XII		XIV	
	pH	EC	pH	EC	pH	EC	pH	EC	pH	EC	pH	EC	pH	EC
		mmhos/cm		mmhos/cm		mmhos/cm		mmhos/cm		mmhos/cm		mmhos/cm		mmhos/cm
Surface	7.4	0.3	7.0	0.6	6.9	0.5	7.2	0.3	7.2	0.6	7.0	0.7	7.1	0.4
15	7.4	0.7	7.1	0.7	7.0	0.9	7.4	1.4	7.0	2.2	6.9	2.2	7.2	0.3
30	7.7	0.4	7.3	0.5	7.1	1.6	7.3	1.9	7.5	4.0	7.3	2.5	7.4	0.3
45	7.4	2.2	7.3	1.9	7.2	2.8	7.6	2.7	7.7	4.4	7.4	2.7	7.5	0.3
60	7.4	2.6	7.5	3.2	7.5	4.5	8.1	7.6	7.8	5.0	7.5	2.5	7.6	0.2
75	7.6	3.1	7.8	6.4	7.7	4.8	8.2	9.8	7.8	5.1	7.7	4.4	7.7	0.3
90	7.8	4.5	8.0	8.4	7.7	4.8	8.0	6.8	8.0	6.3	7.8	4.9	7.7	0.4
105	8.0	8.5	8.1	8.6	7.9	7.2	8.1	9.2	8.0	7.7	7.9	5.0	7.9	0.3
120	7.9	6.4	8.2	10.2	7.8	7.4	7.9	4.0	8.2	7.4	7.9	5.3	7.4	0.3
135	8.1	9.3	-	-	7.9	6.4	7.7	3.6	8.2	7.4	8.0	6.4	-	-
150	8.1	8.3	-	-	7.8	5.0	7.0	5.7	-	-	7.9	5.0	-	-

APPENDIX TABLE 32. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE TOSCO SHALE TREATMENTS, NORTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1977.

	30 cm Soil Cover/TOSCO						15 cm Soil Cover/TOSCO						TOSCO Spent Shale						Soil Control		
	I			III			V			VII			IX			XI			XIII		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
PERENNIAL GRASSES																					
Western wheatgrass	48*	62	42	63	46	65	96	61	70	77	146	120	207	233	303	55	128	145	34	97	24
Bluebunch wheatgrass	21	35	10	36	77	25	15	25	26	42	40	43	20	-	-	3	-	3	46	8	52
Indian ricegrass	9	6	53	20	3	25	20	-	-	15	12	10	-	-	-	-	-	-	-	-	-
Slender wheatgrass	8	27	30	-	10	38	4	5	9	13	-	-	-	-	-	-	-	-	-	-	-
Crested wheatgrass	-	-	-	-	-	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basin wildrye	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SHRUBS																					
Winterfat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fourwing saltbush	-	-	-	5	2	-	50	9	-	49	13	3	58	38	22	100	55	15	105	56	51
Big sage	-	-	-	2	-	11	-	13	-	-	-	-	5	-	-	-	-	-	-	-	-
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FORBS																					
Scarlet globemallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Penstemon	-	-	21	-	5	23	4	18	72	10	18	44	-	-	-	-	-	3	4	4	13
Utah sweetvetch	-	-	-	-	-	-	5	22	-	-	3	-	-	-	-	-	-	-	-	-	-
OTHER SPECIES																					
Cheatgrass	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Russian thistle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO VEGETATIVE COVER	116	122	71	152	114	50	59	113	82	64	48	71	20	23	6	72	25	15	65	50	81
LITTER	92	62	51	73	83	49	99	72	53	57	73	56	8	42	-	20	71	1	197	109	66
STANDING LITTER	14	8	82	-	35	136	20	11	60	108	100	24	238	212	322	93	116	204	69	31	57

* Values are total cm of above ground vegetative cover by species. Transect lines averaged 350 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 33. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE TOSCO SHALE TREATMENTS, SOUTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1977.

	30 cm Soil Cover/TOSCO						15 cm Soil Cover/TOSCO						TOSCO Spent Shale						Soil Control		
	II			IV			VI			VIII			X			XII			XIV		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
PERENNIAL GRASSES																					
Western wheatgrass	33*	94	80	43	95	107	87	64	54	120	53	90	272	205	187	38	98	112	31	10	18
Bluebunch wheatgrass	54	29	9	-	27	23	7	-	26	29	26	6	-	-	-	2	-	-	-	-	11
Indian ricegrass	35	32	14	57	23	26	85	46	24	8	33	35	-	-	-	37	7	41	45	35	73
Slender wheatgrass	-	-	7	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basin wildrye	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SHRUBS																					
Winterfat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fourwing saltbush	170	4	16	156	82	31	44	32	51	28	72	75	18	104	140	49	33	130	108	76	12
Big sage	-	3	13	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	15
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FORBS																					
Scarlet globemallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Penstemon	4	-	-	4	-	2	-	4	29	-	-	8	-	-	-	-	-	-	-	-	-
Utah sweetvetch	-	-	-	-	-	-	17	11	8	19	-	-	-	-	-	-	-	-	-	-	-
OTHER SPECIES																					
Cheatgrass	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Russian thistle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO VEGETATIVE COVER	67	67	91	119	83	33	31	111	71	25	58	52	32	42	33	47	55	19	125	215	77
LITTER	19	105	89	41	79	43	44	55	48	65	68	34	-	-	-	97	152	33	64	26	97
STANDING LITTER	-	-	53	-	12	98	51	55	75	137	46	97	284	255	235	170	45	237	10	-	110

* Values are total cm of above ground vegetative cover by species. Transect lines averaged 350 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 34. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE USBM SHALE TREATMENTS, NORTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1977.

	30 cm Soil Cover/USBM						15 cm Soil Cover/USBM						USBM Spent Shale						Soil Control		
	13			11			9			7			5			3			1		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
PERENNIAL GRASSES																					
Western wheatgrass	34*	65	54	37	66	88	99	54	82	85	62	134	4	36	172	39	96	223	90	111	169
Bluebunch wheatgrass	-	19	-	22	19	23	42	42	34	46	74	7	6	32	13	59	51	-	4	8	12
Indian ricegrass	11	38	9	51	14	16	18	11	17	-	21	9	19	9	-	22	-	11	81	-	-
Slender wheatgrass	-	-	-	-	-	-	-	5	26	-	4	7	-	-	5	-	-	-	-	-	-
Crested wheatgrass	-	-	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basin wildrye	-	-	3	-	-	21	14	11	-	-	-	-	-	-	-	-	-	-	-	28	7
SHRUBS																					
Winterfat	-	-	-	-	-	-	-	-	18	-	-	-	-	-	-	-	-	-	-	-	-
Fourwing saltbush	56	66	19	46	40	27	39	77	-	41	23	-	133	130	43	133	158	8	-	-	-
Big sage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	16
Rabbitbrush	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FORBS																					
Scarlet globemallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Penstemon	-	3	15	-	2	17	-	-	37	-	15	9	-	-	-	-	-	-	33	4	53
Utah sweetvetch	-	-	-	-	-	2	19	5	3	27	15	-	-	-	3	-	-	-	-	14	-
OTHER SPECIES																					
Cheatgrass	-	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Russian thistle	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-
NO VEGETATIVE COVER	152	88	66	113	161	68	17	75	12	56	67	51	37	60	18	40	10	58	44	14	15
LITTER	92	79	99	75	38	85	115	78	60	118	61	76	118	13	12	74	89	51	72	98	10
STANDING LITTER	5	4	90	9	-	24	119	23	136	-	40	136	31	95	247	59	111	225	113	159	250

* Values are total cm of above ground vegetative cover by species. Transect lines averaged 350 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 35. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE USBM SHALE TREATMENTS, SOUTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1977.

	30 cm Soil Cover/USBM						15 cm Soil Cover/USBM						USBM Spent Shale						Soil Control		
	14			12			10			8			6			4			2		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
PERENNIAL GRASSES																					
Western wheatgrass	27*	19	62	40	64	76	50	81	44	126	96	45	71	40	67	43	78	149	34	70	88
Bluebunch wheatgrass	5	-	5	6	26	12	80	-	30	20	30	29	21	39	13	13	12	12	29	-	11
Indian ricegrass	18	35	34	27	27	33	11	54	9	13	7	28	5	19	8	14	5	-	12	20	-
Slender wheatgrass	-	-	23	-	-	4	-	-	4	-	-	3	-	-	-	-	-	-	7	-	21
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basin wildrye	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SHRUBS																					
Winterfat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
Fourwing saltbush	55	83	70	97	31	62	68	21	68	85	21	68	186	139	79	159	108	80	93	-	18
Big sage	-	-	-	-	-	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-	34
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FORBS																					
Scarlet globemallow	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Penstemon	2	-	-	8	-	-	4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Utah sweetvetch	-	-	-	-	-	-	-	4	-	-	10	-	-	-	-	-	-	-	18	8	3
OTHER SPECIES																					
Cheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-
Russian thistle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO VEGETATIVE COVER	109	192	126	136	163	52	43	83	56	64	64	21	9	63	55	46	75	24	56	135	65
LITTER	100	-	25	43	45	97	59	78	31	78	78	68	61	53	52	63	68	63	74	40	65
STANDING LITTER	15	3	21	-	-	70	119	75	135	11	63	74	57	66	154	50	51	176	69	62	103

* Values are total cm of above ground vegetative cover by species. Transect lines averaged 350 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 36. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE TOSCO SHALE TREATMENTS, NORTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1977.

Depth (cm)	30 cm Soil Cover/TOSCO										15 cm Soil Cover/TOSCO									
	I					III					V					VII				
	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14
15	19.8*	18.7	7.0	7.5	21.5	22.0	21.0	6.7	6.8	21.5	10.3	5.0	3.3	6.0	13.3	6.3	5.0	3.0	5.2	9.0
30	17.5	22.7	13.7	10.0	17.3	19.2	22.7	13.2	11.0	20.0	16.0	21.0	7.5	10.0	10.0	10.3	22.0	8.5	9.3	14.8
45	16.0	19.5	17.0	12.5	19.0	18.3	20.3	18.2	13.5	20.0	16.8	22.7	11.5	11.0	8.3	10.3	16.2	7.7	11.8	9.0
60	18.3	19.5	20.5	12.5	19.0	18.3	18.7	19.8	14.3	17.7	17.5	21.0	13.2	12.5	10.7	7.2	10.5	6.5	12.5	6.7
75	17.5	18.7	19.5	11.7	19.0	17.5	17.8	20.5	14.3	17.7	18.3	19.5	16.5	14.3	13.3	9.5	10.5	3.5	13.5	6.7
90	17.5	17.8	18.0	13.5	18.2	18.3	17.8	21.5	14.3	17.0	19.2	21.0	19.8	15.0	15.7	12.7	11.3	11.8	12.5	7.5
105	17.5	17.0	17.0	11.5	17.3	18.3	17.8	17.3	15.0	17.7	19.2	20.3	20.5	15.0	17.3	16.0	13.7	16.5	13.5	8.3
120	17.5	16.2	19.5	16.0	19.0	18.3	18.7	18.2	16.8	17.0	20.8	18.7	19.8	15.0	18.2	16.0	16.2	15.7	16.0	10.0
135	18.3	17.8	20.5	14.3	21.5	18.3	17.8	19.0	11.5	17.7	21.5	20.3	21.5	16.8	21.5	16.8	17.8	18.8	16.8	10.6
150	21.5	20.3	22.2	18.5	23.0	19.2	18.7	21.5	11.5	17.7	21.5	20.3	22.3	19.3	21.5	19.2	19.5	18.0	19.3	13.3
165	23.2	22.0	25.5	18.7	22.5	--	--	--	--	--	--	--	--	--	--	20.8	20.3	20.3	21.8	15.8

Depth (cm)	TOSCO Spent Shale										Soil Control				
	IX					XI					XIII				
	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14
15	7.2	5.0	1.8	3.5	13.2	4.7	3.2	1.0	5.3	8.3	26.3	15.5	5.5	7.7	25.5
30	10.3	15.2	1.0	9.3	12.3	14.3	15.2	21.8	10.0	10.7	26.3	26.8	12.7	13.5	21.5
45	6.3	9.0	3.5	10.0	9.0	12.7	17.0	8.5	11.0	8.3	18.3	23.5	16.0	16.8	18.2
60	5.5	6.5	6.8	11.0	6.7	11.2	13.8	10.0	12.5	8.3	15.2	15.5	14.3	17.5	16.5
75	7.8	7.3	5.2	12.5	7.5	12.7	15.2	11.8	14.3	10.0	15.2	15.5	15.0	17.5	17.3
90	11.2	10.5	6.8	13.5	9.0	16.0	16.2	15.0	15.0	12.3	16.0	15.5	15.3	18.5	17.3
105	13.5	15.3	10.0	13.5	10.0	19.2	18.7	16.0	16.8	14.0	16.0	15.5	16.0	16.0	17.3
120	14.8	16.2	13.5	16.0	11.5	20.8	18.7	18.5	19.3	14.0	--	--	--	--	--
135	17.5	17.0	12.5	17.5	12.3	23.2	19.5	21.0	18.5	18.0	--	--	--	--	--
150	17.5	17.0	16.8	18.5	14.0	24.0	22.7	23.5	21.0	20.5	--	--	--	--	--
165	19.2	19.5	17.5	21.0	16.5	24.0	22.7	25.3	21.0	21.0	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No readings.

APPENDIX TABLE 37. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE TOSCO SHALE TREATMENTS, SOUTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1977.

Depth (cm)	30 cm Soil Cover/TOSCO										15 cm Soil Cover/TOSCO									
	II					IV					VI					VIII				
	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14
15	16.0*	17.8	7.8	6.8	21.5	17.5	19.5	1.7	6.8	22.2	1.0	1.0	1.7	4.3	7.5	6.3	9.8	1.7	5.2	16.5
30	19.2	24.3	15.0	12.5	19.8	17.5	18.7	11.7	11.0	15.7	19.2	19.5	9.0	6.8	18.2	14.3	19.5	9.0	6.0	16.5
45	11.2	15.5	16.8	16.8	13.2	14.3	15.5	12.3	15.0	15.7	17.5	22.0	11.5	10.0	14.0	12.7	17.8	11.5	7.5	10.0
60	12.7	14.5	19.2	11.5	14.8	13.5	14.5	14.8	16.0	14.8	16.8	20.3	12.3	12.5	13.2	11.2	17.8	12.3	7.5	10.0
75	13.5	14.5	18.3	11.5	14.7	16.0	15.5	17.3	16.0	15.7	18.3	19.5	14.8	15.0	14.8	14.3	15.5	14.8	8.5	10.7
90	15.0	15.5	17.5	16.8	14.8	17.5	16.3	18.0	18.5	16.5	19.2	17.0	16.5	18.5	16.5	16.8	15.5	16.5	11.0	11.5
105	16.8	16.3	16.0	16.0	15.7	19.2	17.0	19.0	18.5	16.5	19.2	18.8	19.0	18.5	18.2	19.2	18.7	19.0	11.8	14.8
120	16.8	16.3	16.8	16.8	14.8	18.3	17.0	19.8	11.5	16.5	19.2	18.8	18.2	18.5	19.0	19.2	21.0	18.2	16.0	14.8
135	16.8	17.0	17.5	16.8	15.7	17.5	17.0	21.5	18.5	14.8	19.2	18.8	19.0	19.3	19.3	19.2	19.5	19.0	17.5	16.5
150	--	--	--	--	--	17.5	17.0	22.2	20.0	15.7	18.3	19.5	20.5	20.0	20.5	20.8	20.3	20.5	19.3	16.5
165	--	--	--	--	--	22.3	20.3	22.3	21.0	16.3	20.8	20.3	21.5	24.3	21.5	--	--	--	--	--

Depth (cm)	TOSCO Spent Shale										Soil Control				
	X					XII					XIV				
	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14
15	1.0	1.5	3.5	1.8	9.0	8.0	7.3	6.7	1.8	14.8	14.3	17.0	6.5	6.0	21.5
30	8.7	11.3	7.0	3.5	11.5	8.8	12.2	8.8	11.8	14.8	19.2	26.0	16.0	10.0	21.5
45	5.5	9.8	11.7	6.0	9.0	9.5	11.3	12.3	8.5	10.8	20.8	20.3	12.5	13.5	19.0
60	4.8	5.7	15.5	6.0	9.0	12.0	11.3	14.0	9.3	10.0	17.5	17.8	13.5	14.3	19.0
75	3.0	5.7	17.0	6.8	8.3	12.7	11.3	14.8	11.0	10.8	18.3	17.0	14.3	14.3	18.2
90	7.2	6.5	18.0	8.5	9.0	16.0	15.5	15.8	15.0	11.5	16.0	15.5	16.0	16.0	18.2
105	9.5	9.0	17.0	11.0	10.0	16.8	16.2	16.5	15.0	12.5	16.8	15.5	17.0	16.0	16.5
120	12.7	11.3	18.8	13.5	10.7	17.5	17.8	18.2	17.3	12.5	19.2	15.5	17.8	17.0	17.3
135	15.0	13.0	20.5	13.5	13.2	18.3	17.0	17.3	19.3	14.0	--	--	--	--	--
150	16.0	15.5	18.8	14.3	13.2	20.0	17.8	18.2	21.8	14.0	--	--	--	--	--
165	17.5	16.3	23.0	16.0	14.8	20.8	18.7	19.8	23.5	14.8	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

APPENDIX TABLE 38. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE USBM SHALE TREATMENTS, NORTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1977.

Depth (cm)	Soil Control					USBM Spent Shale									
	1					3					5				
	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14
15	22.3*	17.0	7.0	5.2	20.5	13.5	14.5	6.7	6.8	19.8	19.8	17.0	8.7	9.3	19.8
30	20.8	26.8	18.8	15.0	21.5	26.3	24.3	14.8	12.5	24.8	19.8	21.0	15.3	11.0	18.2
45	15.0	18.7	20.2	16.0	17.3	22.3	25.2	19.8	18.5	19.8	18.3	21.8	20.5	12.3	19.0
60	15.0	16.2	18.0	13.5	17.3	18.3	21.0	13.2	15.0	20.5	20.8	19.5	21.3	16.8	16.5
75	16.0	14.5	18.8	15.0	18.2	19.2	19.5	19.8	16.8	17.7	20.8	19.5	19.5	18.5	15.7
90	14.3	15.3	18.0	16.0	18.2	22.3	20.3	20.5	16.8	18.2	20.8	21.8	22.2	19.3	15.7
105	13.5	13.8	15.3	14.3	15.7	22.3	21.0	21.5	19.3	18.2	22.3	22.8	23.8	19.3	17.3
120	12.7	13.0	13.7	13.5	15.7	25.5	25.2	24.7	20.0	19.8	26.3	24.3	25.5	21.8	18.3
135	14.3	13.0	17.0	17.5	16.5	28.0	28.3	28.0	24.3	19.8	25.5	24.3	28.0	18.5	18.3
150	14.3	13.8	16.3	16.8	16.5	28.8	28.3	26.3	25.2	20.3	--	--	--	--	--
165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	15 cm Soil Cover/USBM										30 cm Soil Cover/USBM									
	7					9					11					13				
	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14
15	18.3	20.3	8.7	7.5	24.7	18.3	23.5	11.2	6.8	23.8	19.8	16.3	7.8	7.5	19.8	19.8	18.7	8.3	7.5	22.3
30	18.3	24.3	16.3	12.5	23.0	19.2	26.0	19.3	16.8	22.3	18.3	21.8	16.0	11.8	20.5	18.3	23.5	15.7	9.3	19.0
45	17.5	25.2	18.8	16.0	19.8	18.3	23.5	19.8	17.5	19.8	18.3	20.3	18.5	16.0	16.5	20.8	19.5	13.2	11.8	15.7
60	17.5	24.3	23.0	18.5	20.5	19.2	19.5	19.3	18.5	18.2	19.2	18.7	17.5	17.5	17.3	25.5	18.7	16.5	13.5	15.7
75	21.5	25.2	25.5	22.7	22.3	19.2	21.0	20.8	19.3	18.2	20.8	19.5	20.0	17.5	16.5	26.3	18.7	16.5	14.3	17.3
90	20.8	25.2	26.3	26.0	23.8	20.8	22.8	21.5	19.3	19.0	20.8	21.0	21.0	18.5	18.2	25.5	18.7	15.7	14.3	16.5
105	19.2	26.0	27.2	26.8	23.0	21.5	22.8	22.3	21.0	19.0	23.2	21.0	18.5	17.5	16.5	28.0	17.8	18.2	16.0	15.7
120	19.2	26.0	28.5	27.7	26.3	20.8	24.3	21.5	20.0	19.8	24.0	22.8	20.0	18.5	15.7	28.7	18.7	21.5	18.5	14.8
135	19.2	28.3	29.8	26.8	28.0	22.3	26.0	25.5	25.2	21.5	26.3	21.8	20.0	17.5	15.7	29.5	17.0	22.3	18.5	14.8
150	--	--	--	--	--	24.0	28.3	27.2	27.7	24.0	28.0	23.5	21.0	17.5	16.5	--	--	--	--	--
165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

APPENDIX TABLE 39. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE USBM SHALE TREATMENTS, SOUTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1977.

Depth (cm)	Soil Control					USBM Spent Shale									
	2					4					6				
	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14
15	15.3*	21.0	6.0	6.8	19.8	12.8	15.3	8.3	7.5	19.0	12.8	12.2	5.2	6.0	21.5
30	20.5	26.0	11.8	10.0	19.8	18.8	21.8	13.2	13.5	21.5	20.5	23.5	13.5	13.5	18.2
45	17.0	18.7	16.0	13.5	16.5	17.0	22.7	14.8	19.3	18.2	17.0	21.0	16.8	14.3	16.5
60	16.3	16.3	15.0	16.0	15.7	17.0	18.7	18.2	18.5	19.0	16.3	17.0	15.0	15.0	16.5
75	16.3	15.2	17.0	16.0	17.3	19.5	17.0	19.0	17.5	21.5	16.3	17.0	17.5	16.0	16.5
90	17.0	16.3	15.0	15.0	17.3	19.5	17.8	19.8	16.8	20.5	17.0	16.3	16.8	16.8	15.7
105	16.3	14.5	14.3	11.8	17.3	20.5	19.5	19.0	19.3	20.5	17.0	16.3	18.5	16.8	17.3
120	13.7	14.5	15.0	12.5	14.8	20.5	19.5	20.5	21.8	21.2	20.5	17.0	19.3	18.5	19.2
135	13.7	13.8	13.2	13.5	14.0	24.8	21.0	21.5	27.7	23.8	23.8	19.8	20.0	19.3	19.2
150	15.3	13.8	14.3	12.5	14.8	--	--	--	--	--	--	--	--	--	--
165	18.2	16.5	16.8	13.5	16.5	--	--	--	--	--	--	--	--	--	--

Depth (cm)	15 cm Soil Cover/USBM										30 cm Soil Cover/USBM									
	8					10					12					14				
	/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14	3/24	4/26	6/16	7/21	9/14
15	12.0	13.0	13.7	7.5	19.8	9.5	8.8	3.8	5.2	19.8	19.5	17.8	9.8	8.5	23.8	16.3	15.3	6.3	6.8	22.3
30	23.0	25.2	18.0	17.5	21.5	28.0	22.7	14.3	14.3	20.5	16.3	18.7	16.2	13.5	19.0	19.5	24.3	15.3	12.5	19.8
45	21.3	26.0	20.5	18.5	19.8	23.8	25.2	19.5	17.5	20.5	15.3	15.2	17.0	16.0	18.2	16.3	19.5	17.0	14.3	20.5
60	19.5	21.0	23.0	19.3	18.2	18.8	21.0	20.3	18.5	19.0	15.3	14.5	14.5	16.8	18.2	16.3	16.2	18.8	15.0	19.0
75	19.5	19.5	19.5	18.5	18.2	18.0	19.5	19.5	17.5	19.0	16.3	14.5	16.3	16.8	18.2	16.3	16.2	20.5	17.5	21.5
90	20.5	19.5	20.5	18.5	17.3	20.5	19.5	21.2	18.5	19.0	17.0	15.2	18.7	17.5	18.2	18.8	18.7	22.2	18.5	19.8
105	22.0	21.0	21.3	18.5	18.2	23.8	21.0	23.8	20.0	19.8	18.0	11.2	19.5	17.5	18.2	18.0	20.3	21.3	21.0	19.8
120	24.0	22.7	22.2	18.5	19.8	26.3	21.7	26.5	21.8	21.5	18.8	17.8	20.3	17.5	18.2	20.5	21.0	22.2	21.0	21.5
135	26.3	24.3	22.3	21.0	23.0	28.8	24.2	25.5	21.0	22.2	20.5	18.7	18.7	16.8	18.2	24.8	22.7	23.8	21.0	22.3
150	--	--	--	--	--	28.8	26.0	27.3	23.5	23.8	21.8	20.3	21.8	19.3	19.0	23.8	21.8	20.5	21.8	21.5
165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

APPENDIX TABLE 40. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE TOSCO SHALE TREATMENTS, NORTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1978.

	30 cm Soil Cover/TOSCO						15 cm Soil Cover/TOSCO						TOSCO Spent Shale						Soil Control		
	I			III			V			VII			IX			XI			XIII		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
PERENNIAL GRASSES																					
Western wheatgrass	128*	95	198	147	119	234	82	117	239	69	172	237	106	163	256	42	119	260	60	56	236
Bluebunch wheatgrass	-	-	-	-	-	-	17	-	-	15	-	-	-	-	-	-	-	-	-	-	-
Slender wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basin wildrye	-	32	25	-	22	48	11	10	21	13	-	18	-	-	30	-	5	7	-	-	14
Indian ricegrass	20	-	-	31	12	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
Galleta	-	-	-	-	-	-	4	-	-	-	29	-	20	10	-	-	-	-	-	9	-
Needle and thread	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bluegrass	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FORBS																					
Penstemon	-	-	3	-	-	-	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-
Utah sweetvetch	-	-	-	-	-	2	-	11	18	-	7	7	-	-	-	-	-	-	-	-	-
SHRUBS																					
Big sage	-	-	48	-	-	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21
Winterfat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fourwing saltbush	5	-	-	96	14	-	92	79	26	128	69	22	128	61	40	124	82	67	98	54	14
OTHER SPECIES																					
Cheatgrass	34	39	-	-	-	-	-	24	2	3	-	-	-	-	-	-	-	-	23	50	-
Russian thistle	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mustard	2	5	8	-	-	11	-	-	-	-	2	-	-	-	-	-	3	-	4	12	11
Kochia	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wild barley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
NO VEGETATIVE COVER	63	125	10	80	113	18	21	49	5	9	25	15	67	38	9	85	31	22	100	147	55
LITTER	36	49	63	36	52	16	121	66	27	98	36	48	9	70	-	121	105	-	51	15	7

* Values are in total cm of above ground vegetative cover by species. Transect lines averaged 350 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 41. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE TOSCO SHALE TREATMENTS, SOUTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1978.

	30 cm Soil Cover/TOSCO						15 cm Soil Cover/TOSCO						TOSCO Spent Shale						Soil Control		
	II			IV			VI			VIII			X			XII			XIV		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
PERENNIAL GRASSES																					
Western wheatgrass	25*	65	192	115	82	139	91	131	159	126	124	149	125	171	116	16	25	131	38	39	139
Bluebunch wheatgrass	-	-	-	-	-	-	-	-	-	-	29	-	-	-	-	10	-	-	-	-	22
Slender wheatgrass	-	22	17	-	14	13	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basin wildrye	-	7	17	15	-	20	9	-	7	-	-	15	-	-	16	-	-	8	-	5	-
Indian ricegrass	13	21	28	11	12	8	13	17	10	5	8	4	-	-	-	-	-	-	36	19	30
Galleta	-	-	-	11	-	-	-	-	-	-	-	-	-	6	-	-	5	-	-	-	-
Needle and thread	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-
Bluegrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FORBS																					
Penstemon	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-
Utah sweetvetch	-	-	5	-	-	-	-	30	3	-	30	8	-	-	-	-	-	-	-	-	7
SHRUBS																					
Big sage	-	-	7	-	-	-	20	-	-	-	-	8	-	-	-	-	-	-	-	-	82
Winterfat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fourwing saltbush	18	54	-	14	79	23	42	55	53	61	11	61	97	56	26	43	99	136	69	54	4
OTHER SPECIES																					
Cheatgrass	98	-	3	10	13	12	-	6	-	-	-	-	-	-	-	-	-	-	-	50	33
Russian thistle	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mustard	-	10	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kocnia	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wild barley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO VEGETATIVE COVER	171	135	65	160	85	51	82	36	47	98	90	79	37	31	127	122	202	-	140	160	32
LITTER	5	25	6	17	80	74	50	64	56	49	48	49	74	76	55	141	9	74	22	18	22

* Values are in total cm of above ground vegetative cover by species. Transect lines averaged 350 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 42. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE USBM SHALE TREATMENTS, NORTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1978.

	30 cm Soil Cover/USBM						15 cm Soil Cover/USBM						USBM Spent Shale						Soil Control		
	13			11			9			7			5			3			1		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
PERENNIAL GRASSES																					
Western wheatgrass	47*	196	124	-	143	204	159	143	208	119	158	192	40	43	141	-	57	184	91	153	158
Bluebunch wheatgrass	-	-	11	-	-	-	12	-	-	25	-	-	-	-	-	13	-	9	-	-	17
Slender wheatgrass	-	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-
Basin wildrye	-	6	10	-	-	17	-	9	34	-	20	26	-	-	3	-	-	3	15	9	32
Indian ricegrass	37	-	23	24	13	5	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-
Galleta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Needle and thread	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Bluegrass	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-	10	-	-
FORBS																					
Penstemon	-	4	5	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-	3	5	-
Utah sweetvetch	-	-	-	-	11	2	-	7	-	5	8	-	8	-	-	-	-	21	9	12	6
SHRUBS																					
Big sage	-	10	-	-	4	49	-	52	40	-	-	75	-	-	-	-	-	-	21	30	-
Winterfat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-
Fourwing saltbush	166	26	69	126	22	9	136	12	36	68	51	-	98	149	12	159	186	36	15	-	-
OTHER SPECIES																					
Cheatgrass	-	8	12	81	-	-	-	3	-	7	-	-	-	7	-	-	3	-	31	39	14
Russian thistle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-
Mustard	-	-	17	-	14	-	-	-	14	-	-	3	-	2	23	-	3	5	-	-	48
Kochia	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	5	-	-	-	-	-
Wild barley	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-
NO VEGETATIVE COVER	86	86	-	74	98	21	18	51	17	69	51	39	103	14	81	155	22	60	69	79	26
LITTER	9	4	62	51	29	31	21	61	-	37	35	5	86	122	84	3	72	24	62	9	49

* Values are in total cm of above ground vegetative cover by species. Transect lines averaged 350 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 43. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE USBM SHALE TREATMENTS, SOUTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1978.

	30 cm Soil Cover/USBM						15 cm Soil Cover/USBM						USBM Spent Shale						Soil Control		
	14			12			10			8			6			4			2		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
PERENNIAL GRASSES																					
Western wheatgrass	101*	51	207	85	152	135	150	106	94	78	77	181	31	43	158	38	54	144	95	95	228
Bluebunch wheatgrass	-	-	-	-	-	-	-	-	35	-	14	-	-	-	-	-	14	-	-	-	-
Slender wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basin wildrye	5	-	9	12	30	20	-	4	-	-	-	7	-	-	18	-	-	3	6	-	39
Indian ricegrass	41	63	30	27	-	12	18	-	-	16	19	-	25	15	7	-	-	-	13	-	4
Galleta	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Needle and thread	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bluegrass	-	-	-	-	-	10	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-
FORBS																					
Penstemon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Utah sweetvetch	-	-	3	4	-	-	8	-	-	7	-	-	-	-	-	-	-	-	-	-	-
SHRUBS																					
Big sage	8	-	22	-	-	20	33	-	47	-	-	-	-	-	-	-	-	102	12	-	10
Winterfat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fourwing saltbush	51	64	-	122	56	28	42	94	52	182	80	20	96	123	82	144	129	45	47	8	-
OTHER SPECIES																					
Cheatgrass	-	-	-	-	-	26	3	33	82	-	-	48	-	5	-	-	-	-	44	92	35
Russian thistle	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mustard	-	-	18	-	-	-	-	-	-	-	-	5	-	-	-	3	17	-	-	-	-
Kochia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wild barley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO VEGETATIVE COVER	92	181	49	98	60	19	53	67	19	43	91	43	144	34	30	129	76	-	106	81	22
LITTER	38	17	7	-	51	69	23	31	11	38	43	17	44	109	40	26	61	45	17	62	2

* Values are in total cm of above ground vegetative cover by species. Transect lines averaged 350 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 44. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE TOSCO SHALE TREATMENTS, NORTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1978.

Depth (cm)	30 cm Soil Cover/TOSCO												15 cm Soil Cover/TOSCO											
	I						III						V						VII					
	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13
15	23.0*	12.1	9.0	5.8	5.2	4.7	21.5	15.7	10.6	7.2	6.0	5.7	21.0	6.8	5.6	2.9	2.4	2.4	18.0	5.8	4.6	2.5	2.9	6.1
30	22.0	18.0	11.6	8.3	7.6	7.6	19.0	20.1	15.1	9.7	9.9	9.6	19.0	19.5	10.8	6.3	5.3	4.6	11.0	12.3	11.0	6.9	6.6	5.8
45	17.5	20.5	13.8	10.4	9.1	9.6	16.5	21.5	15.6	12.3	12.0	11.1	15.0	18.2	13.6	7.3	5.8	5.1	7.0	15.8	10.5	6.4	6.1	5.8
60	14.0	20.5	16.5	13.6	13.2	12.1	15.0	18.9	15.6	13.4	13.0	11.6	11.5	17.0	13.6	7.3	6.7	5.6	6.5	12.3	9.9	6.4	5.7	5.3
75	13.0	19.2	16.5	14.7	12.7	12.1	13.0	17.5	16.3	14.5	13.0	12.1	12.5	15.8	14.2	9.3	7.7	7.0	6.5	11.2	9.9	6.4	5.7	5.3
90	13.0	15.5	14.9	14.1	12.1	11.6	12.5	17.5	15.6	13.9	12.0	12.7	12.5	14.0	14.8	10.0	8.2	7.0	8.0	8.4	8.8	6.9	6.1	5.3
105	15.0	14.0	13.8	13.6	12.7	11.6	13.0	16.3	15.6	13.4	12.8	12.1	12.5	13.5	14.2	10.4	8.7	7.5	9.0	9.0	8.3	6.9	6.1	5.8
120	15.0	14.0	13.8	13.0	12.7	12.7	13.5	15.1	14.5	12.8	12.8	11.6	14.5	13.5	13.6	11.4	9.7	8.5	10.5	9.0	8.3	6.9	6.6	6.2
135	--	15.5	15.4	13.6	14.8	14.3	--	15.1	14.0	12.8	12.8	11.1	--	14.6	13.6	11.4	10.2	9.0	12.5	10.0	8.8	7.9	7.1	6.2
150	--	16.7	16.5	16.9	15.3	15.3	--	--	--	--	--	11.1	--	--	--	--	--	10.9	--	12.3	11.0	9.5	8.1	7.2

Depth (cm)	TOSCO Spent Shale												Soil Control					
	IX						XI						XIII					
	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13
15	17.0	6.8	3.7	2.0	1.9	1.5	15.5	4.4	2.2	1.0	1.5	1.5	27.5	14.6	9.5	5.2	5.2	4.7
30	12.0	14.6	7.3	4.3	3.8	3.8	10.0	12.7	7.4	3.8	3.8	3.8	23.0	23.4	14.6	11.1	10.0	9.6
45	7.5	14.6	11.7	5.3	5.2	4.8	8.0	14.9	12.5	6.2	5.6	5.2	15.5	23.4	15.8	11.6	11.6	11.1
60	6.5	13.5	11.2	5.8	5.7	5.8	9.5	12.1	11.9	7.2	6.0	5.7	12.5	22.1	15.8	11.6	11.1	11.6
75	8.0	11.2	11.2	6.2	6.1	5.8	10.0	9.5	10.8	7.2	6.0	5.7	--	18.2	16.4	11.6	11.6	11.6
90	9.5	9.0	9.5	6.7	6.1	6.2	10.5	10.0	10.8	7.7	7.0	6.6	--	14.6	14.0	11.1	11.6	11.1
105	10.5	9.5	9.0	7.2	6.6	6.2	12.0	10.5	11.3	8.2	8.0	6.6	--	--	--	--	--	--
120	11.5	10.0	10.6	8.2	6.6	6.2	13.0	11.6	12.5	9.2	8.0	6.6	--	--	--	--	--	--
135	11.5	10.0	11.2	8.7	7.6	6.7	--	12.7	13.1	10.2	8.5	7.1	--	--	--	--	--	--
150	--	11.2	11.2	9.2	8.1	7.2	--	12.7	13.7	10.2	8.5	7.1	--	--	--	--	--	--

* Values are percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

APPENDIX TABLE 45. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE TOSCO SHALE TREATMENTS, SOUTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1978.

Depth (cm)	30 cm Soil Cover/TOSCO												15 cm Soil Cover/TOSCO											
	II						IV						VI						VIII					
	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13
15	22.0*	13.5	11.0	6.7	5.7	5.1	19.0	13.2	9.5	6.1	5.2	5.8	23.0	4.8	4.3	1.5	1.5	1.5	19.0	9.0	5.9	2.8	2.0	2.9
30	20.0	18.2	12.7	9.7	9.1	9.0	18.0	18.0	11.7	7.6	7.6	7.7	21.5	18.2	10.4	5.3	4.8	4.6	16.5	17.0	12.2	6.1	5.9	5.3
45	15.0	19.5	13.8	7.7	7.1	7.0	15.0	18.0	14.0	8.1	7.6	8.2	19.5	20.1	13.9	6.8	6.7	5.6	15.5	18.2	13.3	7.1	6.9	6.2
60	11.0	18.2	15.0	9.7	9.6	8.0	13.0	17.3	15.2	11.1	10.0	9.2	16.5	20.1	15.7	9.8	8.2	6.0	13.0	17.0	14.5	8.1	6.9	6.7
75	10.5	17.0	14.4	11.3	10.0	9.5	11.0	16.7	15.2	11.6	11.1	10.7	15.0	20.1	17.0	10.4	9.2	8.0	--	15.8	14.5	9.6	8.4	6.7
90	10.0	14.6	14.4	12.3	10.6	9.5	10.0	15.5	15.8	11.6	11.6	10.7	12.0	18.9	17.0	10.9	10.2	8.5	--	14.0	13.9	10.0	7.9	6.7
105	10.5	12.3	12.1	11.3	11.1	9.9	10.5	14.4	13.5	12.1	11.6	10.3	12.5	16.3	16.3	11.4	10.7	9.0	--	--	--	--	--	--
120	--	11.2	12.1	10.8	10.0	9.5	10.5	12.1	12.9	11.6	10.6	10.2	12.5	15.1	15.1	11.4	10.7	9.9	--	--	--	--	--	--
135	--	11.2	11.0	10.2	10.0	9.0	--	12.1	12.3	10.6	9.6	9.2	12.5	13.9	14.5	12.0	11.3	9.9	--	--	--	--	--	--
150	--	--	--	--	--	--	--	12.1	12.3	10.6	10.0	9.7	--	13.9	14.5	12.5	11.8	10.5	--	--	--	--	--	--

Depth (cm)	TOSCO Spent Shale												Soil Control					
	X						XII						XIV					
	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13
15	15.5	4.7	2.2	1.1	1.0	1.5	15.5	10.0	4.7	2.5	2.4	2.0	30.0	16.2	11.2	5.8	5.7	4.8
30	13.5	11.2	6.3	2.9	3.3	3.3	12.5	15.2	11.7	5.8	4.7	4.3	21.5	23.0	16.4	11.3	11.1	9.7
45	9.5	12.9	10.0	4.8	5.3	4.2	8.5	14.6	13.5	7.8	6.6	5.8	14.5	23.7	17.0	12.3	11.1	11.3
60	7.0	13.5	11.2	6.3	5.3	5.1	7.5	12.3	12.3	7.8	6.6	5.8	13.5	23.0	16.4	12.3	11.6	11.8
75	7.5	11.7	10.6	7.3	5.8	5.1	7.5	11.2	11.7	7.8	7.1	6.2	13.5	16.7	16.4	12.3	11.6	11.8
90	8.0	9.0	9.5	6.8	5.3	5.1	7.5	10.0	11.2	8.3	7.1	6.2	14.0	13.2	13.5	11.8	11.6	11.8
105	8.5	7.9	8.4	6.8	6.2	5.1	7.5	9.0	10.0	8.3	7.1	5.8	--	13.2	13.5	12.3	11.6	11.3
120	8.5	8.4	8.4	6.8	6.2	6.0	7.5	10.0	10.0	8.3	7.6	6.2	--	13.2	13.5	11.8	11.1	11.3
135	9.0	9.0	7.8	6.8	6.2	6.0	8.0	9.5	9.5	7.8	8.1	6.7	--	--	--	--	--	--
150	--	10.0	12.4	6.8	6.7	5.6	--	9.5	9.0	7.8	7.6	6.7	--	--	--	--	--	--

* Values are percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

APPENDIX TABLE 46. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE USBM SHALE TREATMENTS, NORTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1978.

Depth (cm)	30 cm Soil Cover/USBM												15 cm Soil Cover/USBM											
	13						11						9						7					
	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13
15	23.5*	16.5	11.0	7.2	5.2	5.1	23.0	14.0	10.3	5.3	5.3	4.7	24.5	19.2	12.9	8.3	8.3	7.2	23.0	17.6	11.4	7.3	6.1	6.5
30	21.5	21.4	15.5	11.3	10.0	9.9	16.5	22.1	14.2	11.4	10.7	10.0	20.5	21.7	17.4	13.0	12.5	11.3	23.0	20.8	14.1	11.4	10.0	10.9
45	15.5	23.3	18.0	12.3	12.1	12.0	14.5	23.4	17.7	13.0	12.8	12.7	19.0	22.4	18.6	14.1	13.0	12.3	20.0	23.4	17.5	14.1	11.6	12.0
60	13.0	23.3	20.5	13.4	12.7	11.5	14.5	19.5	17.1	12.5	11.8	12.1	15.5	21.7	18.6	14.1	12.5	12.8	19.0	24.7	20.4	15.8	13.7	13.5
75	13.0	20.1	19.2	13.4	12.7	12.0	14.5	18.9	17.6	12.5	11.8	12.1	15.0	19.8	18.6	14.7	13.6	12.8	18.0	23.4	19.2	16.9	15.9	13.5
90	12.5	15.3	14.4	12.3	11.6	10.9	12.5	16.4	16.5	14.1	12.8	12.1	15.5	19.2	17.4	14.1	13.0	11.8	18.0	22.1	19.8	16.3	15.9	14.0
105	12.5	14.2	13.2	11.8	11.1	10.9	12.0	14.6	15.3	13.6	12.8	12.1	16.0	16.7	16.3	14.7	13.0	12.3	19.5	20.8	19.2	18.0	16.4	15.6
120	--	13.0	12.7	11.8	11.6	10.5	12.5	13.5	13.6	12.5	11.8	11.6	17.5	16.2	16.3	14.7	14.1	12.8	--	22.1	19.2	17.5	17.0	16.2
135	--	13.0	12.7	11.3	11.1	10.5	--	13.5	13.6	12.0	11.8	11.6	--	16.2	15.6	15.2	13.6	12.8	--	22.1	20.4	19.2	18.0	17.3
150	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	USBM Spent Shale												Soil Control					
	5						3						1					
	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13
15	25.0	17.0	11.9	7.2	6.6	5.8	26.0	13.3	10.5	5.9	5.2	4.8	25.0	15.5	8.1	5.4	4.4	4.3
30	20.0	22.1	16.5	12.3	11.1	10.7	23.0	22.4	16.7	11.6	11.1	10.2	25.0	23.0	15.3	11.0	10.4	9.7
45	15.0	22.1	18.9	13.4	12.7	11.8	18.5	23.8	19.2	12.7	12.7	12.3	18.5	23.7	15.9	11.0	11.4	10.7
60	13.5	21.4	18.9	12.8	12.7	12.3	14.5	22.4	19.2	13.2	12.7	12.3	11.5	25.7	17.5	12.7	12.5	11.8
75	14.0	18.2	17.6	12.3	11.6	11.3	13.5	21.1	19.2	13.8	12.7	12.8	11.0	23.7	19.2	12.7	12.5	12.3
90	14.5	14.6	14.2	11.3	11.1	11.3	15.5	18.5	16.7	12.7	12.7	12.3	11.5	15.5	13.2	12.7	12.0	11.3
105	15.0	14.6	14.2	12.3	12.1	12.3	15.5	14.7	14.4	13.8	15.3	12.3	12.0	12.7	11.1	12.1	11.4	10.7
120	--	14.6	14.2	13.4	12.7	12.8	15.5	16.7	15.5	16.0	13.7	15.0	11.5	12.1	11.1	11.6	11.4	10.7
135	--	14.6	19.1	13.9	13.2	12.3	--	16.1	15.0	14.3	--	12.8	--	13.2	11.1	12.7	11.4	11.0
150	--	--	--	--	--	--	--	--	--	--	--	--	--	13.2	11.1	12.1	11.4	11.3

* Values are percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

APPENDIX TABLE 47. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE USBM SHALE TREATMENTS, SOUTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1978.

Depth (cm)	30 cm Soil Cover/USBM												15 cm Soil Cover/USBM											
	14						12						10						8					
	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13
15	22.0*	15.8	9.9	6.9	5.3	4.8	16.0	15.5	12.3	7.8	7.2	7.0	24.0	9.9	7.7	5.0	4.1	4.3	25.0	11.2	9.2	5.3	5.9	3.8
30	13.5	19.5	13.8	9.5	9.7	9.7	12.0	18.5	13.5	10.9	9.7	9.0	22.5	19.2	14.4	10.1	9.8	9.7	20.5	19.5	15.1	12.0	11.6	10.1
45	13.5	22.1	17.3	12.1	11.8	11.3	12.0	16.7	14.6	12.0	11.8	10.9	18.5	19.8	15.5	13.4	11.3	12.3	19.0	22.1	18.9	13.0	13.2	11.6
60	14.0	20.1	18.0	12.1	11.8	11.8	13.5	13.2	14.0	12.0	12.3	11.5	15.5	20.5	17.3	12.9	11.8	12.8	14.0	20.8	17.5	12.5	11.6	11.6
75	14.5	15.8	15.5	12.7	12.3	12.3	12.5	13.8	13.5	12.0	11.8	12.0	15.5	20.5	18.0	13.4	11.8	11.8	14.0	19.5	17.5	12.5	11.6	11.6
90	15.0	15.2	15.0	13.8	14.5	15.0	12.0	14.4	14.0	12.5	12.8	12.0	16.5	19.2	18.0	13.4	13.8	12.3	14.0	17.0	16.3	12.0	12.1	11.6
105	14.5	15.2	15.5	14.9	14.5	13.9	12.5	14.4	13.5	12.0	11.8	12.0	16.5	18.0	16.2	15.1	13.8	13.4	16.5	15.2	16.3	12.5	12.1	11.6
120	14.0	15.8	15.5	14.9	15.0	15.0	13.0	13.2	13.5	12.0	12.3	11.5	18.5	16.7	16.7	15.1	13.8	13.9	--	15.3	15.7	13.6	12.7	12.1
135	13.5	15.2	16.2	14.9	13.9	13.2	--	14.4	14.0	12.0	11.3	12.0	--	16.7	15.5	15.1	13.3	13.4	--	17.0	16.3	14.1	13.8	13.2
150	--	14.6	15.0	14.3	12.8	12.8	--	--	--	--	--	--	--	18.0	16.7	15.6	14.4	13.9	--	--	--	---	--	--

Depth (cm)	USBM Spent Shale												Soil Control					
	6						4						2					
	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13	4/6	5/16	6/7	7/13	8/9	9/13
15	23.0	13.9	11.2	5.3	6.1	4.7	25.5	15.5	12.1	7.4	6.3	9.7	26.5	15.8	9.9	5.3	5.7	4.3
30	23.0	21.5	17.0	10.7	10.0	10.0	24.5	20.5	16.7	11.0	10.9	11.8	27.5	22.1	13.2	9.8	9.6	9.2
45	19.0	20.1	18.2	11.8	11.6	11.1	19.0	21.7	19.2	12.1	11.4	12.3	21.5	22.7	16.2	11.4	11.1	10.2
60	13.5	21.5	19.5	11.8	12.1	11.6	16.0	21.0	19.2	12.7	12.0	12.8	14.0	23.4	16.7	11.4	11.6	11.3
75	13.0	20.8	20.1	12.3	12.1	11.6	17.0	20.5	19.2	13.8	13.0	13.4	12.0	22.1	16.7	12.0	11.6	11.8
90	13.5	17.0	17.0	12.3	11.6	11.1	17.0	16.7	16.7	13.8	13.6	13.4	12.0	15.8	14.4	11.4	12.1	11.8
105	--	13.8	14.6	11.3	11.1	11.1	17.5	14.4	15.2	14.3	13.6	13.9	12.0	12.9	11.5	11.4	11.1	10.7
120	--	15.1	13.5	12.3	12.1	11.1	--	15.5	16.7	14.9	14.1	15.0	12.5	12.3	11.0	10.4	11.1	10.7
135	--	--	--	--	--	--	--	16.7	16.7	16.0	15.8	--	--	12.3	11.5	10.4	10.6	10.2
150	--	--	--	--	--	--	--	--	--	--	--	--	--	13.5	12.7	12.0	11.6	10.7

* Values are percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

APPENDIX TABLE 48. SALINITY MEASUREMENTS (EC) OF CORE SAMPLES FROM THE HIGH-ELEVATION STUDY SITE, AUGUST 1978.

TOSCO Spent Shale

Depth (cm)	North Aspect							South Aspect						
	30 cm Soil Cover		15 cm Soil Cover		TOSCO Spent Shale		Soil	30 cm Soil Cover		15 cm Soil Cover		TOSCO Spent Shale		Soil
	I	III	V	VII	IX	XI	XIII	II	IV	VI	VIII	X	XII	XIV
15	1.5*	1.8	1.7	1.2	4.5	7.2	2.3	1.4	1.5	1.4	3.3	6.2	7.0	1.3
30	1.7	1.5	6.4	4.7	5.8	7.1	2.2	1.8	1.4	4.8	7.3	6.5	7.8	1.4
45	11.4	11.6	6.2	4.7	6.1	6.9	2.4	6.7	9.7	6.1†	7.0	7.0	9.0	1.9
60	13.0	13.0	7.6	6.0	6.2	6.6	1.9	9.7	13.0	†	8.1	6.9	7.6	1.9
75	12.4	13.7	8.4	6.8	6.4	7.1	2.2	9.8	14.0	6.3	9.4	7.6	9.1	2.0
90	12.4	12.8	6.9	5.0	6.4	7.1	2.0	11.3†	12.7	6.4	9.4	7.2	8.2	1.7
105	11.8	13.5	6.2	5.8	6.1	7.1	2.0	†	13.5†	7.0	7.0	7.3	5.5	2.1
120	9.5	9.8†	6.8	6.5	5.4	6.7	2.4	11.4		6.3	7.2	7.9	6.4	1.6
135	10.0	†	4.6	6.4	5.7	7.1	--	10.4	12.0	7.1	6.6	7.8	7.2	--
150	9.1	†	6.8	6.1	5.5	7.3	--	--	12.0	6.4	6.5	8.0	8.0	--
165	7.8	8.3	6.5	5.8	6.3	7.2	--	--	10.3	--	--	8.0	7.4	--

USBM Spent Shale

Depth (cm)	North Aspect							South Aspect						
	30 cm Soil Cover		15 cm Soil Cover		USBM Spent Shale		Soil	30 cm Soil Cover		15 cm Soil Cover		USBM Spent Shale		Soil
	13	11	9	7	5	3	1	14	12	10	8	6	4	2
15	1.4	0.6	0.7	1.0	1.3	1.0	1.0	1.0	6.6	7.0	1.0	1.3	1.2	0.4
30	1.1	0.6	1.1	1.2	2.5	1.2	0.5	0.9	0.9	1.0	2.4	1.4	1.2	0.5
45	2.1	2.4	1.7	4.5	4.0	3.2	0.8	9.2	1.0	1.2	1.4	5.2	4.7	0.7
60	6.6	4.4	4.1	6.2	4.9	2.2	0.7	10.3	3.7	4.5	4.2	6.5	1.9	0.7
75	9.4	5.4	4.2	5.0	3.6†	3.6	0.9	7.4	5.7	4.5	2.7	5.3	2.2	0.5
90	8.0	7.5	5.0	3.8	5.4	4.0	0.7	6.0	6.8	4.4	4.7	5.5	4.5	0.6
105	7.0	6.2	2.7	4.0	5.2	5.1	0.6	5.8	6.8	4.2	4.1	5.7	4.7	0.7
120	6.4	6.0	3.0	4.5	4.1	5.8	0.8	6.7	6.0	4.1	5.3	4.8	5.0	0.9
135	3.9	--	--	--	--	--	0.8	6.4	6.2	3.6	--	5.2	6.4	0.6
150	5.3	--	---	--	--	--	0.6	6.0	6.9	4.8	--	6.4	7.0	0.3
165	--	--	--	--	--	--	--	5.6	--	--	--	6.2	--	--

* EC values are in mmhos/cm @ 25°C measured on a 1:1 spent shale to water by weight sample.

† Denotes a composited sample.

-- No sample collected.

APPENDIX TABLE 49. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE TOSCO AND USBM SHALE TREATMENTS, NORTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1979.

Species	NORTH ASPECT													
	30 cm/TOSCO		15 cm/TOSCO		TOSCO		30 cm/USBM		15 cm/USBM		USBM		Soil Control	
	I	III	V	VII	IX	XI	13	11	9	7	5	3	XIII	1
PERENNIAL GRASSES														
Western wheatgrass	202*	409	476	568	45[illegible]	442	207	285	324	227	111	261	280	367
Bluebunch wheatgrass	-	42	-	25	-	-	-	-	15	-	-	-	-	2
Basin wildrye	145	149	70	46	-	-	40	44	87	68	30	13	23	147
Indian ricegrass	-	-	-	-	-	-	18	-	-	-	-	-	5	-
Crested wheatgrass	22	-	-	-	-	-	-	-	-	-	-	-	-	-
SHRUBS														
Big sage	10	17	-	-	-	15	-	95	157	191	-	20	25	15
Fourwing saltbush	-	20	171	276	301	355	360	280	203	229	413	593	233	-
Winterfat	-	-	-	-	-	-	-	-	-	-	-	-	-	15
FORBS														
Utah sweetvetch	-	8	10	-	-	-	-	-	4	-	-	-	-	-
OTHER SPECIES														
Cheatgrass	230	107	55	-	-	-	129	231	56	77	96	25	417	463
Mustard	300	22	-	-	-	-	108	55	-	-	-	-	20	-
NO VEGETATIVE COVER	189	225	285	95	114	244	134	147	161	175	357	157	154	87
LITTER	-	102	-	86	187	84	58	21	100	123	48	15	62	25

* Values are in total cm of above ground vegetative cover by species. Each plot represents the total of three transect lines approximately 350 cm in length each. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 50. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE TOSCO AND USBM SHALE TREATMENTS, SOUTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1979.

	SOUTH ASPECT													
	30 cm/TOSCO		15 cm/TOSCO		TOSCO		60 cm/USBM		15 cm/TOSCO		USBM		Soil Control	
	II	IV	VI	VIII	X	XII	14	12	10	8	6	4	XIV	2
PERENNIAL GRASSES														
Western wheatgrass	104*	277	344	366	116	124	358	408	231	130	107	112	590	570
Bluebunch wheatgrass	-	-	-	40	-	-	-	-	-	-	-	-	-	-
Indian ricegrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SHRUBS														
Fourwing saltbush	529	573	220	165	129	309	207	95	326	411	225	315	-	170
Rabbitbrush	-	-	30	73	-	-	15	-	20	-	-	-	-	-
Winterfat	62	50	18	36	113	137	116	114	166	137	270	228	-	52
FORBS														
Scarlet globemallow	-	-	30	21	-	-	-	15	-	-	-	-	18	-
OTHER SPECIES														
	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cheatgrass	30	85	292	123	30	69	152	92	108	130	141	226	10	142
Dandelion	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dock	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kochia	-	-	8	-	-	-	-	-	-	-	-	-	-	-
Mustard	69	25	15	22	-	15	-	20	-	-	5	-	39	-
Russian thistle	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO VEGETATIVE COVER	89	132	70	266	101	168	202	176	151	224	228	178	216	184
LITTER	267	112	90	98	541	248	98	146	91	115	81	26	161	32

* Values are in total cm of above ground vegetative cover by species. Each plot represents the total of three transect lines approximately 350 cm in length each. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 51. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE TOSCO SHALE TREATMENTS, NORTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1979.

Depth (cm)	30 cm Soil Cover/TOSCO												15 cm Soil Cover/TOSCO											
	I						III						V						VII					
	4/25	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11
15	19.0*	22.0	11.0	6.8	12.0	7.8	18.3	22.0	12.0	7.8	11.8	8.5	10.0	11.5	6.8	3.5	11.3	4.5	8.3	9.5	6.0	3.5	9.0	4.3
30	24.3	27.0	14.0	8.3	9.0	8.8	23.0	25.8	17.8	11.3	10.3	10.0	22.5	25.0	11.3	7.3	8.3	6.0	22.5	25.0	13.0	8.3	9.5	7.3
45	25.3	26.5	17.5	9.7	10.0	9.8	24.3	25.7	19.0	13.3	12.7	11.5	22.5	25.0	18.3	9.3	7.3	6.5	21.8	23.0	14.5	6.3	7.0	7.3
60	25.3	25.8	19.5	15.0	12.5	12.3	23.5	25.0	19.0	15.0	14.0	14.8	21.8	22.5	17.8	11.8	8.8	9.0	17.8	20.8	14.0	8.3	6.0	6.3
75	23.0	24.5	19.5	15.0	13.5	12.8	22.5	23.0	19.5	15.5	15.0	14.8	19.5	22.5	18.3	13.3	11.3	11.0	16.5	19.5	14.5	10.3	7.5	6.8
90	20.5	22.0	19.0	15.0	14.0	13.3	20.5	22.0	19.5	16.5	15.0	14.3	18.3	20.8	17.8	14.5	12.3	11.5	12.3	17.8	14.5	11.3	9.5	7.8
105	17.3	19.0	18.5	15.5	14.0	12.8	18.3	22.0	18.3	17.3	14.5	14.8	15.3	19.0	19.0	15.5	13.3	12.8	7.3	12.8	14.5	11.8	10.0	9.3
120	15.8	17.8	18.0	16.5	14.5	14.5	16.8	18.8	17.3	16.5	15.5	14.3	11.0	16.5	19.0	16.5	14.5	13.3	6.3	12.8	13.5	11.8	10.5	9.3
135	14.5	19.0	20.0	19.5	16.8	16.0	13.0	17.8	17.8	17.3	15.5	14.8	9.0	11.5	18.3	15.5	14.5	13.8	6.8	6.5	13.0	12.3	10.5	9.8
150	14.0	17.0	20.0	20.0	19.5	17.8	12.0	--	--	--	--	--	10.0	11.5	19.0	--	--	--	7.3	6.5	11.5	12.3	11.0	9.8

Depth (cm)	TOSCO Spent Shale												Soil Control					
	IX						XI						XIII					
	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11
15	11.3	14.8	4.8	1.5	9.3	3.8	11.3	11.5	3.5	1.5	6.8	3.3	19.5	23.0	9.5	6.3	13.0	7.8
30	16.5	21.3	10.0	3.8	6.3	4.3	18.3	23.0	11.5	4.3	6.3	4.3	25.5	28.3	15.8	11.8	13.0	11.3
45	16.5	19.5	11.5	4.8	5.3	4.8	18.4	20.8	14.0	6.3	6.3	5.3	25.5	28.3	15.8	13.3	12.0	12.3
60	17.3	19.5	13.0	5.8	6.3	5.3	16.5	18.5	14.0	7.8	6.8	5.3	25.5	27.0	16.8	12.3	11.0	11.8
75	14.5	18.3	14.0	8.3	6.8	6.3	15.0	17.0	14.0	9.8	7.8	6.3	23.0	28.3	19.5	12.3	11.0	11.8
90	9.3	13.8	13.5	10.8	8.3	7.3	9.8	15.5	16.3	12.3	9.8	8.8	--	27.0	20.5	11.8	11.5	12.3
105	6.8	6.5	11.5	9.8	8.3	7.3	8.3	8.0	14.5	12.3	10.3	9.3	--	--	--	--	--	--
120	6.3	6.5	7.5	7.8	7.3	7.3	7.3	6.8	9.5	9.8	9.3	8.8	--	--	--	--	--	--
135	6.3	6.5	7.0	6.3	7.3	6.3	7.3	6.8	7.5	8.3	7.8	7.3	--	--	--	--	--	--
150	6.8	6.8	6.5	6.3	6.3	6.3	7.3	7.5	7.5	7.3	7.3	7.3	--	--	--	--	--	--

* Values are percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

APPENDIX TABLE 52. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE TOSCO SHALE TREATMENTS, SOUTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1979.

Depth (cm)	30 cm Soil Cover/TOSCO												15 cm Soil Cover/TOSCO											
	II						IV						VI						VIII					
	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11
15	16.5*	20.0	10.3	7.3	12.0	8.3	17.3	20.0	9.5	7.0	14.0	7.0	6.0	6.5	4.3	2.3	9.3	3.3	10.0	12.8	7.8	3.5	12.0	5.0
30	22.5	25.0	12.8	10.8	11.0	9.3	22.5	24.3	12.5	8.0	9.3	7.5	21.3	25.8	14.0	6.0	9.8	5.8	21.8	24.5	16.0	6.3	9.0	6.5
45	21.3	23.8	14.0	9.3	7.5	7.3	21.3	22.5	14.5	9.0	8.3	7.5	21.8	24.5	16.3	8.0	7.3	6.3	20.5	23.0	15.0	7.8	6.0	6.5
60	21.3	21.8	15.0	10.8	9.0	8.3	21.3	22.5	15.8	11.5	9.8	9.0	21.8	22.0	16.8	11.0	9.3	7.3	18.3	20.0	15.0	8.8	6.5	6.5
75	17.8	19.0	16.0	12.8	11.0	9.8	20.0	20.0	15.8	13.0	12.3	11.0	20.0	22.0	16.8	13.0	10.8	9.8	17.8	19.5	15.0	10.8	8.0	6.8
90	15.5	16.0	16.0	13.3	12.0	11.8	18.3	17.8	15.8	14.0	12.8	12.0	17.3	19.5	16.8	13.0	11.8	11.3	16.3	17.8	15.5	11.8	9.0	7.5
105	11.8	14.5	15.0	14.0	12.5	11.8	13.3	15.0	15.8	13.5	13.3	12.0	16.3	17.0	15.8	13.5	12.3	11.3	--	--	--	--	--	--
120	10.3	10.8	13.3	12.8	12.0	11.8	11.3	12.3	14.0	12.5	13.3	12.0	12.5	14.8	15.8	13.5	12.3	10.8	--	--	--	--	--	--
135	9.3	--	13.3	--	--	--	10.3	9.3	12.0	11.0	12.8	11.5	10.0	11.5	14.0	13.0	13.3	11.3	--	--	--	--	--	--
150	--	--	--	--	--	--	9.8	9.3	11.0	10.5	11.3	11.0	10.0	11.5	14.0	12.5	12.8	11.8	--	--	--	--	--	--

Depth (cm)	TOSCO Spent Shale												Soil Control					
	X						XII						XIV					
	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11
15	6.5	10.3	3.3	1.0	5.8	3.3	12.8	18.3	5.0	1.5	8.3	3.3	18.3	22.0	10.0	6.3	15.5	7.3
30	14.5	19.0	7.8	2.8	6.3	4.0	15.0	20.0	9.5	4.3	5.8	4.5	25.5	29.8	14.5	12.3	13.3	11.8
45	14.0	19.0	10.3	4.3	5.3	4.5	15.5	17.8	12.0	6.3	5.3	5.0	25.5	28.8	15.3	12.3	13.3	12.3
60	14.0	17.3	11.7	5.5	5.3	5.0	14.0	15.0	12.0	6.3	5.3	5.5	24.3	27.8	15.3	12.3	12.3	11.8
75	11.0	14.5	12.8	7.0	6.3	6.0	12.3	12.8	12.0	7.3	5.8	5.5	21.3	25.8	15.8	12.3	12.3	11.8
90	7.0	6.3	11.3	8.0	6.8	6.5	9.3	10.3	11.0	7.3	6.3	6.0	13.0	16.0	15.7	11.3	12.3	11.8
105	5.5	5.8	7.3	6.5	6.3	6.5	7.3	7.3	8.5	6.8	5.8	5.5	11.5	11.5	12.0	10.8	11.3	11.8
120	5.5	5.3	5.8	5.0	6.3	6.0	6.3	6.3	6.5	5.8	5.8	6.0	11.5	11.5	12.0	11.8	11.8	11.8
135	5.0	5.3	5.8	5.0	5.8	5.5	6.3	6.3	6.0	5.3	6.3	6.0	--	--	11.5	--	--	--
150	6.0	5.8	5.8	5.5	6.3	5.5	6.3	6.3	6.0	5.8	5.8	6.0	--	--	--	--	--	--

* Values are percent moisture by volume as determined from a standard soil moisture curve.

-- No reading

APPENDIX TABLE 53. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE USBM SHALE TREATMENTS, NORTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1979.

Depth (cm)	30 cm Soil Cover/USBM												15 cm Soil Cover/USBM											
	13						11						9						7					
	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11
15	21.3*	26.3	11.5	8.3	14.0	8.0	18.3	23.0	10.5	7.5	15.3	8.5	22.5	24.3	15.3	10.0	14.0	10.3	19.5	23.0	13.5	7.5	15.3	8.3
30	25.5	28.8	16.3	12.8	12.5	10.5	24.3	28.8	17.3	12.5	13.5	11.5	24.3	26.3	17.3	13.0	13.0	11.8	22.5	24.3	18.3	13.0	14.0	11.3
45	26.3	28.8	18.3	12.3	12.0	11.5	24.3	25.0	17.8	14.0	13.0	12.8	25.0	26.3	19.5	13.0	13.5	11.8	23.0	25.5	21.3	15.8	13.0	12.3
60	26.3	26.3	19.5	12.3	12.0	11.0	21.3	21.3	18.3	12.0	12.0	12.0	21.3	23.0	19.0	13.0	12.0	11.8	24.3	23.0	21.3	16.8	15.3	14.5
75	22.5	23.8	19.5	14.5	12.0	11.5	21.3	23.8	19.0	14.0	12.0	12.8	21.8	22.5	19.0	13.5	12.5	12.3	22.5	21.8	21.3	16.8	15.3	14.5
90	16.5	17.8	18.3	13.3	11.5	11.5	20.0	22.5	20.5	15.3	12.0	12.8	20.8	22.5	18.3	13.5	12.5	11.8	21.8	21.8	21.3	17.8	15.3	13.3
105	12.3	14.5	16.3	13.3	12.0	11.0	16.3	20.0	20.0	14.5	12.5	12.8	17.3	19.5	18.3	13.5	13.0	11.8	21.8	20.5	21.3	17.8	15.8	14.0
120	11.3	10.8	13.0	12.3	11.5	10.5	12.0	14.5	17.8	14.5	11.5	12.0	13.3	15.5	17.8	13.5	12.5	12.3	19.0	14.0	21.8	18.3	15.8	15.0
135	11.3	11.3	11.0	11.3	11.0	10.0	11.0	12.3	15.8	13.0	12.0	11.5	12.8	12.8	18.3	14.0	13.0	12.3	17.3	--	21.8	20.0	16.8	16.0
150	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	USBM Spent Shale												Soil Control					
	5						3						1					
	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11
15	20.0	23.8	14.0	7.5	12.0	8.3	18.3	19.0	11.0	6.5	15.3	6.3	17.8	19.5	9.0	6.0	13.5	6.3
30	22.5	25.0	19.0	13.0	12.0	11.3	23.0	25.0	16.8	12.0	12.5	10.3	26.3	26.0	15.3	12.0	13.0	11.3
45	23.0	26.3	20.5	14.5	12.5	12.8	23.8	25.5	18.3	13.0	13.0	12.3	26.3	27.3	16.3	11.5	12.0	11.8
60	21.3	23.8	20.0	14.0	13.0	13.3	22.5	24.3	19.5	12.5	13.0	12.8	28.8	29.3	16.8	12.5	12.0	12.3
75	20.0	22.5	19.5	13.5	11.5	10.8	21.3	23.8	19.5	13.0	13.0	12.8	27.5	27.3	18.3	12.5	12.5	12.3
90	19.0	22.5	18.3	13.5	11.5	11.3	17.8	21.3	19.0	12.5	12.0	12.3	22.5	24.3	17.8	12.0	11.5	11.8
105	14.5	21.3	19.0	14.5	12.5	11.8	12.8	15.5	18.3	12.0	12.0	11.8	15.5	19.5	17.8	11.5	12.0	10.8
120	13.3	14.5	19.5	14.5	13.0	13.3	14.5	15.5	19.0	15.5	13.5	14.0	12.3	12.0	14.0	11.5	12.0	10.8
135	13.3	--	17.8	--	--	--	12.3	14.0	15.8	14.0	13.0	12.8	11.8	12.0	13.0	11.5	13.0	11.8
150	--	--	--	--	--	--	--	--	--	--	--	--	11.8	11.5	11.5	11.5	--	11.8

* Values are percent moisture by volume as determined from a standard soil moisture curve.

-- No reading.

APPENDIX TABLE 54. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE USBM SHALE TREATMENTS, SOUTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1979.

Depth (cm)	30 cm Soil Cover/USBM												15 cm Soil Cover/USBM											
	14						12						10						8					
	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11
15	17.8*	22.5	8.8	6.3	13.0	9.3	20.0	25.0	11.0	8.8	13.0	8.3	12.8	16.5	7.3	4.3	15.3	6.8	14.5	19.0	10.3	7.3	14.0	7.3
30	23.8	25.0	12.3	10.3	11.5	11.3	23.8	26.3	13.0	11.3	12.0	10.8	22.5	24.3	14.5	11.0	13.0	10.5	23.8	26.3	18.3	14.0	13.0	11.8
45	22.5	23.8	15.0	11.8	11.5	10.8	22.5	24.3	15.8	11.8	11.5	11.8	24.3	26.3	17.8	13.5	12.5	12.0	23.0	25.0	20.0	14.0	13.0	12.8
60	22.5	22.5	16.5	11.8	11.5	11.8	21.3	21.8	16.3	12.3	11.5	11.3	23.0	23.8	18.3	13.0	12.5	12.8	20.0	22.5	17.8	12.3	11.5	11.3
75	16.5	17.8	17.8	14.0	11.5	12.3	19.0	22.5	17.8	13.3	12.0	11.3	21.3	22.5	19.0	14.0	12.5	13.3	20.0	21.3	17.8	12.3	11.0	11.3
90	14.5	15.5	18.3	16.0	14.0	13.3	13.3	16.5	17.8	14.0	12.5	12.3	21.3	22.5	19.5	14.0	12.5	13.8	18.3	20.8	16.5	12.8	11.0	11.3
105	13.3	15.0	16.0	15.5	14.0	13.3	12.3	13.3	13.5	13.3	12.0	11.8	17.3	20.0	19.5	15.8	13.0	13.8	14.5	16.5	17.8	13.3	11.5	11.8
120	14.5	13.3	15.5	14.5	13.5	14.5	11.8	11.3	12.0	12.3	12.0	11.8	13.3	15.5	20.0	15.3	13.5	13.8	12.8	14.5	17.8	13.3	12.5	11.8
135	13.3	12.3	14.5	12.8	13.0	14.0	11.8	12.3	11.5	11.8	11.5	11.8	13.5	13.3	15.5	14.0	13.0	14.3	14.0	14.5	16.0	14.5	13.5	12.3
150	12.3	--	12.8	12.8	13.0	13.3	--	--	--	--	--	--	13.5	13.3	15.0	14.0	14.0	14.3	--	--	--	--	--	--

Depth (cm)	USBM Spent Shale												Soil Control					
	6						4						2					
	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11	4/24	5/15	6/18	7/16	8/20	9/11
15	14.5	18.3	11.3	6.5	15.5	7.5	16.3	20.8	11.5	7.8	15.3	9.0	16.8	22.0	9.5	6.3	14.5	7.8
30	20.5	17.8	19.0	11.0	14.0	10.6	21.8	24.5	16.8	11.8	13.0	10.5	23.0	27.0	13.0	10.3	11.8	10.8
45	20.0	23.8	18.3	12.0	12.3	11.5	21.8	25.8	18.3	12.8	12.5	11.5	26.0	28.3	14.0	11.3	12.3	11.3
60	21.8	24.3	20.8	13.0	13.3	12.8	21.8	25.0	19.0	13.3	13.0	12.8	25.5	27.0	15.8	12.3	12.3	11.8
75	20.5	23.0	20.0	14.5	12.3	12.8	20.5	23.8	19.0	14.0	13.0	13.3	24.3	26.5	17.3	12.3	12.3	12.3
90	18.3	20.0	20.0	13.5	12.3	12.0	19.5	23.0	19.5	14.0	14.0	13.8	18.3	19.5	17.3	12.3	12.3	11.8
105	13.5	17.3	17.8	13.0	11.3	11.5	14.5	17.8	19.5	15.0	14.0	13.8	12.0	12.8	13.5	11.3	11.8	11.3
120	12.0	13.3	18.3	14.0	11.8	12.0	14.0	15.5	17.3	15.5	15.3	14.8	11.0	11.5	11.5	10.8	10.8	10.8
135	--	--	--	--	--	--	--	14.8	--	--	--	--	11.0	11.0	10.5	10.8	10.8	10.8
150	---	--	--	--	--	--	--	--	--	--	--	--	11.0	11.5	11.0	11.3	11.3	11.3

* Values are percent moisture bv volume as determined from a standard soil moisture curve.

-- No reading.

APPENDIX TABLE 55. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE TOSCO AND USBM SHALE TREATMENTS, NORTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1980.

Species	North Aspect													
	30 cm Soil/ TOSCO		15 cm Soil/ TOSCO		TOSCO Spent Shale		30 cm Soil/ USBM		15 cm Soil/ USBM		USBM Spent Shale		Soil Control	
	I	III	V	VII	IX	XI	13	11	9	7	5	3	XIII	1
PERENNIAL GRASSES														
Western wheatgrass	166*	121	190	176	190	193	77	61	122	88	56	49	198	163
Basin wildrye	203	115	79	44	23	25	8	26	14	26	-	11	80	71
Bluebunch wheatgrass	8	13	-	13	3	-	7	-	-	-	-	-	-	-
Slender wheatgrass	30	101	8	-	2	-	-	-	-	-	-	-	-	-
Indian ricegrass	-	17	10	-	-	-	2	-	-	-	-	-	3	4
Indian ricegrass	-	-	-	-	-	-	-	3	-	-	-	-	11	-
Bluegrass	4	-	-	-	-	-	-	-	-	-	-	-	-	-
SHRUBS														
Fourwing saltbush	18	5	59	105	94	257	322	151	77	273	453	479	112	-
Big sage	7	-	27	14	-	-	31	57	154	108	-	26	-	65
Winterfat	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FORBS														
Utah sweetvetch	-	-	5	10	-	-	-	-	-	-	-	4	-	2
OTHER SPECIES														
Cheatgrass	-	44	15	-	-	-	124	117	10	14	48	40	107	112
Mustard	-	8	-	-	-	-	-	-	-	-	-	-	-	2
Plantain	2	10	-	-	-	-	-	-	-	-	-	-	-	-
NO VEGETATIVE COVER	163	305	198	232	147	126	145	126	218	85	162	92	112	132
LITTER	359	334	413	427	540	460	345	476	436	448	325	319	437	501

* Values are in total centimeters of aboveground vegetative cover by species. Each plot represents a total of three transect lines approximately 350 cm in length each. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 56. VEGETATIVE ANALYSIS (TRANSECT METHOD) OF THE TOSCO AND USBM SHALE TREATMENTS, SOUTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1980.

Species	South Aspect													
	30 cm Soil/ TOSCO		15 cm Soil/ TOSCO		TOSCO Spent Shale		30 cm Soil/ USBM		15 cm Soil/ USBM		USBM Spent Shale		Soil Control	
	II	IV	VI	VIII	X	XII	14	12	10	8	6	4	XIV	2
PERENNIAL GRASSES														
Western wheatgrass	98*	134	121	177	101	70	23	38	42	66	4	30	108	132
Basin wildrye	20	57	56	14	10	4	8	22	12	2	16	-	37	7
Bluebunch wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Slender wheatgrass	-	19	-	-	-	-	-	-	-	-	-	-	-	-
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian ricegrass	-	-	2	-	-	-	2	-	-	2	-	-	-	-
Bluegrass	-	-	-	-	-	-	-	-	-	-	-	-	3	-
SHRUBS														
Fourwing saltbush	59	176	172	100	209	376	384	421	277	396	469	393	67	79
Big sage	28	-	-	-	-	-	-	-	128	-	45	73	30	80
Winterfat	13	-	-	-	-	-	-	-	-	-	-	-	-	-
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	27
FORBS														
Utah sweetvetch	-	-	-	7	-	-	-	-	-	4	-	-	-	-
OTHER SPECIES														
Cheatgrass	166	166	4	-	13	29	180	199	67	149	109	173	188	190
Mustard	-	-	-	-	-	-	-	5	-	2	-	-	4	-
Plantain	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO VEGETATIVE COVER	341	162	192	261	161	185	238	198	114	171	195	156	245	98
LITTER	309	431	450	458	514	368	257	218	410	287	218	255	356	429

* Values are in total centimeters of aboveground vegetative cover by species. Each plot represents a total of three transect lines approximately 350 cm in length each. Line 1 in upper, line 2 in middle, and line 3 in lower 1/3 of each plot.

APPENDIX TABLE 57. MOISTURE MEASUREMFNTS (NEUTRON PROBE) FROM THE TOSCO SHALE TREATMENTS, NORTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1980.

Depth (cm)	30 cm Soil Cover/TOSCO										15 cm Soil Cover/TOSCO									
	I					III					V					VII				
	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13
15	27.5	14.3	3.0	0.8	1.5	26.3	14.5	4.0	1.3	3.0	17.8	10.3	3.5	0.8	2.0	16.5	7.5	3.3	1.3	3.0
30	29.5	20.8	11.5	5.0	6.3	30.3	22.5	10.5	5.8	7.5	25.0	22.5	12.0	4.3	4.8	22.5	20.8	11.3	6.0	7.5
45	28.8	24.5	13.3	6.3	6.7	28.0	22.5	11.0	8.0	8.5	26.3	22.5	13.8	5.3	5.8	15.0	18.3	12.8	6.3	6.5
60	26.8	23.8	14.3	6.0	6.8	25.5	22.5	13.8	8.5	9.5	25.0	21.8	16.5	5.8	5.8	7.8	17.8	14.0	5.5	5.8
75	25.5	22.5	15.5	7.8	7.3	24.3	22.5	15.5	11.0	10.5	23.8	21.8	17.0	6.5	5.8	7.8	18.3	14.5	6.0	6.5
90	21.8	22.0	16.0	10.5	10.0	22.5	21.3	16.0	12.0	12.5	21.8	21.8	17.0	9.0	8.5	8.3	16.5	15.0	8.3	8.0
105	19.0	20.8	16.0	11.5	11.0	21.3	20.8	15.5	12.5	12.0	20.0	21.8	17.0	10.5	10.0	8.8	16.0	15.5	9.3	8.5
120	16.5	19.5	16.5	12.5	11.0	18.3	20.0	16.0	13.5	13.0	17.8	22.5	17.0	12.0	13.5	8.8	16.0	-	9.8	9.0
135	16.0	22.5	16.5	12.5	12.0	16.0	19.0	14.8	13.5	13.5	14.5	21.3	17.8	13.0	12.5	8.8	16.0	-	10.5	9.5
150	16.5	22.0	17.8	14.5	13.5	15.0	-	13.8	13.5	13.5	14.0	22.5	17.8	13.5	12.5	9.3	15.5	-	9.8	10.0

Depth (cm)	TOSCO Spent Shale										Soil Control				
	IX					XI					XIII				
	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13
15	15.5	7.5	1.5	0.0	1.3	12.3	5.8	1.5	0.0	1.3	25.0	14.8	3.3	0.8	2.0
30	14.5	13.8	4.8	2.0	3.0	18.3	14.5	5.3	1.5	2.8	28.0	23.0	12.3	6.0	7.0
45	8.3	13.8	7.8	3.3	3.8	16.5	15.0	8.8	3.8	4.0	28.0	25.0	14.5	10.0	10.0
60	6.8	11.5	9.3	4.5	4.3	9.8	14.5	9.3	4.3	5.0	29.5	24.5	15.0	11.0	10.0
75	6.8	8.5	11.3	5.0	5.3	8.3	14.5	10.3	4.8	5.0	28.8	25.8	14.5	10.5	10.5
90	7.3	7.5	12.3	5.5	5.8	8.3	14.5	11.3	5.8	6.0	28.0	26.5	14.5	10.5	11.0
105	7.8	8.0	11.8	6.3	6.5	8.3	10.3	10.8	8.0	7.3	-	-	14.0	10.0	10.0
120	7.3	6.8	9.3	6.8	6.5	7.8	7.3	8.8	8.5	8.3	-	-	12.8	-	-
135	6.8	6.5	6.8	6.0	6.0	6.8	7.3	6.3	9.0	7.3	-	-	11.8	-	-
150	6.8	6.5	6.3	5.5	6.0	7.3	6.8	5.8	7.5	6.3	-	-	-	-	-

APPENDIX TABLE 58. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE TOSCO SHALE TREATMENTS, SOUTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1980.

Depth (cm)	30 cm Soil Cover/TOSCO										15 cm Soil Cover/TOSCO									
	II					IV					VI					VIII				
	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13
15	20.8	13.8	2.5	1.3	1.3	19.0	13.8	3.0	1.3	2.0	8.3	5.5	3.3	1.3	2.0	12.3	10.5	2.8	0.8	2.0
30	23.0	20.8	9.3	6.8	8.3	23.0	20.8	10.0	5.5	6.3	23.0	22.0	11.3	4.8	5.5	22.5	23.0	11.8	4.5	6.3
45	23.0	20.8	9.8	9.3	9.3	21.8	20.8	12.0	6.8	5.5	21.8	22.0	16.0	6.5	5.5	20.0	18.3	11.8	5.5	5.5
60	22.0	20.8	12.8	7.3	6.3	21.3	19.5	16.0	5.5	5.5	21.3	20.8	17.3	7.0	6.3	19.0	18.3	12.8	5.5	5.5
75	20.8	20.8	17.3	6.8	6.3	20.0	18.3	17.0	6.0	8.3	20.8	20.8	17.8	8.5	8.3	18.3	18.3	14.5	5.5	5.5
90	20.8	19.5	17.3	7.3	6.8	19.0	18.3	18.3	8.3	10.0	19.0	19.5	17.8	10.5	9.3	17.3	18.3	14.5	6.3	5.5
105	18.3	19.0	16.5	9.8	9.3	16.0	17.0	19.0	10.0	11.0	17.8	18.3	19.0	10.5	10.0	-	-	14.5	7.8	6.0
120	14.8	18.3	16.5	11.5	11.0	12.3	15.5	19.5	11.0	11.0	16.0	17.8	19.5	10.0	10.0	-	-	15.0	8.3	-
135	12.8	-	17.3	12.0	11.0	11.3	13.8	18.3	11.0	11.0	13.3	17.0	19.0	12.0	11.0	-	-	15.0	-	-
150	-	-	20.8	12.0	12.0	11.3	12.8	19.5	11.5	10.0	12.3	17.8	20.0	12.0	10.5	-	-	15.5	-	-

Depth (cm)	TOSCO Spent Shale										Soil Control				
	X					XII					XIV				
	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13
15	10.0	5.3	1.0	0.8	2.0	16.5	10.0	1.5	0.3	1.3	21.3	14.8	3.3	1.3	2.8
30	16.0	12.8	4.0	2.0	2.8	19.0	14.8	4.8	2.0	3.0	25.5	23.0	11.8	6.5	8.3
45	17.0	12.8	11.5	3.3	3.8	18.3	14.8	9.3	3.8	3.8	25.5	23.0	14.5	10.5	10.5
60	17.0	14.5	8.5	3.8	3.8	16.0	13.8	10.3	4.3	3.8	25.0	24.5	15.5	11.0	10.5
75	16.5	15.0	9.5	4.5	4.5	14.8	13.8	11.3	4.8	4.8	25.0	23.0	15.5	10.5	10.0
90	13.8	14.0	9.5	5.0	5.0	11.0	12.8	12.8	4.8	4.8	19.0	21.3	17.3	10.5	10.5
105	8.5	11.8	8.5	6.3	5.5	7.5	8.5	13.3	5.3	4.8	13.3	14.8	18.3	11.0	10.0
120	6.5	7.3	7.5	6.8	6.0	6.5	6.5	11.3	5.3	4.8	11.8	11.5	-	10.5	10.0
135	5.5	5.8	6.8	6.0	6.0	6.0	5.5	8.3	5.3	4.8	-	-	-	10.5	10.0
150	6.0	5.3	6.5	4.5	5.5	6.0	6.0	7.3	4.3	4.8	-	-	-	11.0	10.0

APPENDIX TABLE 59. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE USBM SHALE TREATMENTS, NORTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1980.

Depth (cm)	30 cm Soil Cover/USBM										15 cm Soil Cover/USBM									
	13					11					9					7				
	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13
15	25.0	16.5	2.5	1.3	1.3	20.8	13.3	2.0	0.8	2.0	24.5	19.5	3.0	0.8	1.3	22.0	18.3	3.5	1.3	2.0
30	29.0	21.8	11.5	5.0	6.5	25.8	21.8	9.5	4.8	8.5	25.8	22.5	12.8	5.8	7.5	23.8	21.3	11.5	5.8	7.3
45	27.0	23.8	14.8	9.8	10.5	25.8	21.8	12.8	9.5	10.5	24.5	22.5	14.8	11.0	11.0	24.5	21.8	14.8	9.5	9.3
60	25.8	24.3	16.0	10.5	10.5	18.3	19.0	15.5	11.5	11.5	23.0	21.3	14.8	11.0	11.0	23.8	22.5	16.0	11.0	10.0
75	23.0	21.3	18.3	10.5	10.5	14.8	19.0	14.8	11.0	11.0	22.5	22.0	14.8	11.0	11.0	23.8	21.3	18.3	11.5	10.5
90	16.0	20.0	19.0	11.0	11.0	13.3	15.0	16.0	10.5	11.5	21.3	20.8	16.0	11.0	11.0	22.5	21.3	18.3	12.0	11.5
105	12.8	16.5	19.0	11.0	10.5	13.3	12.3	17.8	10.5	11.5	19.5	19.5	16.0	11.5	10.5	19.5	21.8	17.8	12.0	11.0
120	12.8	10.8	17.8	12.0	9.5	12.0	11.8	14.8	11.0	11.5	15.5	19.5	16.0	11.0	10.5	17.0	21.3	17.8	12.0	11.0
135	10.5	10.3	13.8	11.0	10.0	11.5	11.3	12.8	11.0	11.0	13.3	17.8	17.0	11.5	10.5	16.5	19.0	19.5	12.0	10.5
150	-	-	11.5	10.0	10.0	-	-	11.5	11.0	10.5	-	-	18.3	11.5	11.0	-	-	19.5	12.5	10.5

Depth (cm)	USBM Spent Shale										Soil Control				
	5					3					1				
	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13
15	19.5	15.5	2.5	0.3	1.3	20.8	15.5	3.0	0.8	1.3	22.5	14.5	2.5	0.8	2.0
30	22.5	20.8	9.8	4.8	6.5	23.8	20.8	11.5	6.5	7.5	28.3	22.5	11.5	5.3	7.0
45	22.0	21.3	14.0	9.0	9.5	23.8	22.5	13.8	9.5	11.0	27.0	23.0	14.3	10.5	9.5
60	17.0	19.5	14.5	10.5	11.0	23.0	22.5	15.5	11.5	10.5	29.8	25.5	14.3	10.5	10.5
75	12.8	16.5	14.5	11.5	11.0	20.8	22.0	16.5	11.5	11.0	28.3	25.0	14.8	11.0	10.5
90	11.0	12.8	14.5	10.5	10.0	14.8	20.8	16.5	11.0	11.5	20.8	23.0	16.0	11.0	10.5
105	11.5	13.3	12.8	9.0	10.0	12.8	19.0	17.0	11.0	11.5	13.8	19.5	14.8	10.5	10.5
120	12.8	12.8	12.8	10.0	9.5	14.3	18.3	17.0	10.5	11.0	11.5	14.0	13.8	10.0	10.0
135	13.3	-	12.3	11.5	11.0	13.8	14.3	18.3	12.5	11.5	12.8	11.8	12.8	10.0	9.5
150	-	-	12.8	11.5	11.0	-	-	16.0	12.0	12.0	12.0	11.3	12.8	10.0	10.0

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TYPING GUIDE SHEET

APPENDIX TABLE 60. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM THE USBM SHALE TREATMENTS, SOUTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1980.

Depth (cm)	30 cm Soil Cover/USBM										15 cm Soil Cover/USBM									
	14					12					10					8				
	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13
15	20.8	15.5	3.0	0.3	1.3	23.8	16.5	3.0	0.8	3.0	16.0	10.3	1.0	0.0	1.3	17.3	14.0	3.0	0.8	1.5
30	23.0	20.8	10.5	5.3	7.5	23.8	19.0	9.5	5.5	7.5	22.5	20.0	8.0	3.3	6.0	22.5	20.8	12.8	5.5	8.5
45	23.8	21.3	13.3	9.0	9.5	23.0	20.8	11.5	8.8	8.5	23.8	20.8	13.3	8.5	10.0	23.8	20.8	16.0	10.5	10.5
60	23.0	22.0	16.0	10.5	9.5	22.5	19.5	13.3	9.8	10.5	24.5	20.0	13.8	11.0	10.0	19.5	19.0	16.0	11.0	11.0
75	20.8	20.8	17.0	11.0	10.0	21.3	20.8	13.3	9.8	11.0	23.0	20.0	14.8	11.5	11.0	20.0	19.0	13.8	9.3	10.5
90	17.8	19.5	18.3	11.0	11.5	17.8	17.8	14.3	9.8	10.5	23.0	20.8	16.0	10.5	10.5	20.0	18.3	13.8	10.0	10.0
105	14.5	16.0	19.5	12.5	13.5	13.3	12.8	15.5	10.0	10.5	22.0	20.0	17.8	11.0	10.0	20.0	17.8	14.8	10.0	10.5
120	14.0	14.8	17.0	13.5	12.5	11.3	11.5	15.5	11.0	11.0	17.0	19.5	18.3	11.5	10.5	16.5	17.8	15.5	10.5	11.0
135	13.3	13.3	14.8	14.0	12.5	11.3	11.5	12.0	10.0	10.5	14.8	15.5	19.0	12.0	11.0	15.5	16.5	15.5	9.8	10.5
150	12.3	12.0	13.8	13.0	12.5	-	-	11.5	10.0	10.0	14.3	14.0	16.5	11.5	11.0	-	-	16.0	11.5	11.0

Depth (cm)	USBM Spent Shale										Soil Control				
	6					4					2				
	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13	4/16	5/28	6/19	8/21	9/13
15	19.5	13.3	3.0	1.3	2.0	19.0	13.8	2.5	0.8	2.0	21.3	13.3	3.0	1.3	2.0
30	22.0	20.8	11.0	6.0	9.5	22.0	18.3	9.5	5.8	8.5	23.8	20.0	10.0	5.5	7.5
45	23.8	20.8	14.3	8.3	10.5	23.8	20.8	12.8	9.0	9.0	25.5	21.3	13.3	8.8	9.5
60	24.5	20.8	14.8	9.8	10.5	23.0	20.8	14.8	9.5	9.0	25.5	21.8	13.3	10.0	10.5
75	23.0	20.8	16.5	9.8	10.5	23.0	20.8	16.0	11.5	10.5	26.8	22.5	14.3	10.0	10.0
90	21.3	20.8	17.0	10.0	11.0	22.0	20.8	16.5	11.5	11.5	22.5	21.8	14.8	10.5	11.0
105	17.8	18.3	17.0	9.8	10.5	19.5	19.5	17.8	12.0	11.5	14.5	14.5	14.3	10.5	10.5
120	14.3	17.8	16.5	10.0	10.5	16.0	16.5	17.8	11.5	12.0	11.3	10.3	13.8	9.8	10.5
135	-	-	16.0	10.0	10.5	14.8	-	16.5	11.5	12.5	10.3	9.8	11.5	9.8	9.5
150	-	-	-	-	-	-	-	16.0	13.5	13.0	11.8	10.3	11.0	8.8	9.5

APPENDIX TABLE 61. SALINITY MEASUREMENTS (EC) OF CORE SAMPLES FROM THE TOSCO SHALE TREATMENTS AT THE HIGH-ELEVATION STUDY SITE, SEPTEMBER 1980.

NORTH ASPECT

Depth (cm)	TOSCO Spent Shale				15 cm Soil Cover/TOSCO				30 cm Soil Cover/TOSCO				Soil	
	I		III		V		VII		IX		XI		XIII	
	pH	EC	pH	EC	pH	EC	pH	EC	pH	EC	pH	EC	pH	EC
		mmhos/cm		mmhos/cm		mmhos/cm		mmhos/cm		mmhos/cm		mmhos/cm		mmhos/cm
Surface	6.9	0.3	7.1	0.4	7.4	0.3	7.4	0.3	7.2	0.5	7.4	2.3	7.3	0.2
15	7.2	0.3	7.4	0.3	7.5	0.3	7.5	0.3	7.0	0.8	7.6	2.3	7.5	0.3
30	7.1	0.5	7.5	0.5	7.4	0.9	7.5	0.5	7.0	2.0	7.6	2.2	7.6	0.2
45	7.0	1.0	7.2	2.6	7.3	2.0	7.3	2.1	7.4	2.2	7.6	2.3	7.8	0.3
60	7.2	2.9	7.5	3.5	7.4	2.5	7.4	2.6	7.4	2.2	7.7	2.5	7.9	0.3
75	7.5	6.1	7.6	7.0	7.5	2.6	7.6	3.5	7.5	2.6	7.7	2.7	7.8	0.3
90	7.7	8.2	7.9	7.4	7.5	3.0	7.6	2.8	7.6	2.7	7.7	2.5	7.9	0.3
105	8.0	8.0	8.0	8.1	7.7	2.9	7.7	3.4	7.7	3.3	7.9	3.4	7.8	0.3
120	8.1	8.1	8.0	7.1	7.8	3.6	7.7	3.0	7.8	3.0	7.9	3.8	7.9	0.3
135	8.1	8.1	8.1	8.8	7.8	3.6	7.8	3.0	8.0	4.5	8.0	4.6	7.8	0.3
150	-	-	8.1	8.1	7.8	3.7	7.7	2.9	7.9	3.2	8.1	4.9	7.9	0.3

SOUTH ASPECT

Depth (cm)	TOSCO Spent Shale				15 cm Soil Cover/TOSCO				30 cm Soil Cover/TOSCO				Soil	
	II		IV		VI		VIII		X		XII		XIV	
	pH	EC	pH	EC	pH	EC	pH	EC	pH	EC	pH	EC	pH	EC
		mmhos/cm		mmhos/cm		mmhos/cm		mmhos/cm		mmhos/cm		mmhos/cm		mmhos/cm
Surface	7.2	0.4	7.1	0.5	7.1	0.3	7.8	0.3	7.8	0.4	7.4	0.6	7.3	0.3
15	7.3	0.3	7.4	0.3	7.1	0.5	7.7	0.3	7.4	1.2	7.4	0.7	7.5	0.2
30	7.5	0.2	7.3	0.6	7.2	1.8	7.7	0.9	7.3	2.1	7.1	2.2	7.7	0.2
45	7.1	2.1	7.2	2.4	7.2	2.3	7.6	2.0	7.4	2.4	7.2	2.4	7.[illegible]	0.3
60	7.1	2.3	7.3	2.4	7.3	1.9	7.6	2.3	7.5	2.7	7.3	2.6	7.7	0.3
75	7.4	2.9	7.5	3.9	7.4	2.6	7.7	2.6	7.6	2.8	7.4	2.9	7.8	0.3
90	7.9	7.4	7.7	5.0	7.7	3.7	7.7	2.5	7.7	3.6	7.6	4.0	7.8	0.3
105	8.0	7.8	7.7	3.8	7.7	3.5	7.9	3.6	7.7	3.1	7.7	3.8	7.7	0.4
120	8.2	9.4	7.9	7.6	7.9	4.7	7.9	3.0	7.8	3.9	7.7	3.5	7.9	0.3
135	8.2	10.4	8.1	9.8	7.9	4.1	7.9	3.0	7.8	3.1	7.7	3.2	7.8	0.2
150	8.3	12.3	8.3	9.1	8.0	3.7	7.9	2.8	7.8	3.1	7.8	3.3	7.8	0.3